Chapter 3
SURFACE WATER QUALITY

INTRODUCTION

This chapter provides a general description of surface water quality conditions in relation to irrigated agriculture operations in the Central Valley Water Board's jurisdictional area.

The Central Valley is a large, flat, fertile valley that dominates the central portion of California. The northern half of the Central Valley is referred to as the Sacramento Valley, and the southern half is referred to as the San Joaquin Valley. The two halves meet at the shared delta of the Sacramento and San Joaquin Rivers, which flow through the northern (Sacramento Valley) and southern (San Joaquin Valley) halves of the valley, respectively.[1]

The Central Valley is divided into three major hydrologic regions or surface water basins, which are illustrated in Figure 1-1 and are described below:

- The **Sacramento River Basin** contains the entire drainage area of the Sacramento River and its tributaries. It begins upstream of Shasta Lake near the Oregon border and extends south to the Sacramento-San Joaquin Delta, stretching roughly from the northeast corner of California to Sacramento County.
- The **San Joaquin River Basin** contains the entire drainage area of the San Joaquin River and its tributaries. It extends from the Delta and the Cosumnes River in the north to the southern reaches of the San Joaquin watershed, encompassing the area from Sacramento County (including the southeast corner of the county itself) to Madera County (and portions of Fresno County).
- The **Tulare Lake Basin** includes the Southern San Joaquin Valley. It ranges from the southern limit of the San Joaquin River watershed to the crest of the Tehachapi Mountains.

Each of the three basins is divided into watersheds delineated by DWR CalWater boundaries. This section identifies the three basins and their 30 associated watersheds, and all methods used to assess the surface water conditions of the basins. The three Central Valley surface water basins and their associated acreage, rivers/tributaries, and watersheds are listed below.

[1] <http://en.wikipedia.org/wiki/Central_Valley_(California)>.

Basin	Size	Rivers/Tributaries	Watersheds
I. Sacramento River Basin	27,210 square miles	Sacramento River Pit River Feather River Yuba River Bear River American River Cottonwood Creek Stony Creek Cache Creek Putah Creek	A. Pit River Watershed B. Shasta-Tehama Watershed C. Butte-Sutter-Yuba Watershed D. Upper Feather River–Upper Yuba River Watershed E. Lake-Napa Watershed F. Colusa Basin Watershed G. Solano-Yolo Watershed H. American River Watershed
II. San Joaquin River Basin	15,880 square miles	San Joaquin River Cosumnes River Mokelumne River Calaveras River Stanislaus River Tuolumne River Merced River Chowchilla River Fresno River	A. Cosumnes River Watershed B. Delta-Mendota Canal Watershed C. San Joaquin River Watershed D. San Joaquin Valley Floor Watershed E. Delta-Carbona Watershed F. Ahwahnee Watershed G. Mariposa Watershed H. Upper Mokelumne River–Upper Calaveras River Watershed I. Merced River Watershed J. North Valley Floor Watershed K. Stanislaus River Watershed L. Tuolumne River Watershed
III. Tulare Lake Basin	17,650 square miles	Kings River Kaweah River Tule River Kern River	A. Kings River Watershed B. Kaweah River Watershed C. Kern River Watershed D. South Valley Floor Watershed E. Grapevine Watershed F. Coast Ranges Watershed G. Fellows Watershed H. Temblor Watershed I. Sunflower Valley Watershed J. Southern Sierra Watershed

Importance of Surface Water

When compared, the Sacramento River basin represents a smaller land area than the San Joaquin River and Tulare Lake basins yet receives a much larger percentage of California’s precipitation. As early as the late 1800s, planning efforts began to transfer excess water from the Sacramento River to dryer areas in the San Joaquin Valley by means of a number of canals and storage reservoirs along the Sacramento River system. The resulting projects, the Central Valley Project (CVP) and State Water Project (SWP) (described in more detail below) were constructed in the 1930s and 1960s, respectively, to provide flood control and water storage and distribution to support agricultural, urban, and industrial needs. The Central Valley’s success as one of the world’s most productive agricultural regions is due in large part to these extensive water diversion projects, which drastically altered the natural drainage patterns of the Central Valley.

Central Valley Project—Reclamation's CVP is a federal water project undertaken in 1935 that was designed to move some of the abundant water supply in the northern end of the Central Valley to the dry southern end. Shasta Dam is the cornerstone of the CVP, and its waters are diverted for agricultural and municipal supply along the Sacramento River and south via the Delta-Mendota Canal. Up to 90 percent of this water is used for agriculture. The CVP also diverts water from the San Joaquin River into the Madera and Friant-Kern Canals along the east side of the Central Valley. CVP water irrigates more than 3 million acres of farmland and provides drinking water to nearly 2 million consumers.

State Water Project—The SWP was constructed in the late-1950s to convey water from northern to southern California through the Delta at the Harvey O. Banks Pumping Plant (Banks Pumping Plant). The SWP includes pumping and power plants; reservoirs, lakes, and storage tanks; and canals, tunnels, and pipelines that capture, store, and convey surface water. The project is operated by DWR. SWP deliveries are 70 percent urban and 30 percent agricultural, supplying 20 million California residents and more than 600,000 irrigated acres, respectively.

Figure 3 is a conceptual model of surface water hydrology as it pertains to agricultural operations (all figures are found at the end of the chapter).

Agricultural Contaminants—Agricultural production practices can result in a number of pollutants entering water bodies, including sediment, nutrients, pathogens, pesticides, and salts, that may degrade water quality and impose costs on water users. The descriptions of these pollutants that follow are based on Ribaudo and Johansson, 2006. While these descriptions focus on agricultural practices that contribute to water quality degradation, agriculture is not generally the sole source of these pollutants. Urban and industrial sources may also contribute to pollutant loads.

Sediment in surface water is largely a result of soil erosion, which is influenced by soil properties and site-specific agricultural practices. Sediment buildup can reduce the capacity of reservoirs, clog irrigation ditches and drainage canals, block navigation channels, increase dredging costs, increase the probability and severity of floods, increase the cost of water treatment for municipal and industrial water uses, and destroy or degrade aquatic wildlife habitat.

Nitrogen and phosphorus are important crop nutrients that are applied by farmers to cropland. Nitrogen and phosphorus can enter water bodies through runoff and leaching, resulting in eutrophication or increased algae growth—which can result in decreased oxygen levels, fish kills, clogged pipelines, and reduced recreational opportunities. Nitrogen in agricultural streams is correlated with nitrogen inputs from fertilizers, manure used on crops, livestock waste, septic tank systems, and, in some cases, wildlife.

Farmers apply a wide variety of pesticides to control insects (insecticides), weeds (herbicides), fungus (fungicides), and other problems. Potential impacts of pesticide residues on surface water quality include harm to freshwater and marine organisms, damage to recreational/commercial fisheries, and impacts on human health.

Some irrigation water applied to cropland may run off into ditches and receiving waters. This irrigation return flow often carries with it dissolved salts, nutrients, and pesticides. Increased salinity levels in irrigation water can reduce crop yields or damage soils such that some crops can no longer be produced. Increased concentrations of naturally occurring toxic minerals—such as selenium, molybdenum, and boron—can harm aquatic wildlife and impair water-based recreation. Increased levels of dissolved solids and nutrients in public drinking water supplies can increase water treatment costs and force the development of alternative water supplies.

Pathogens are also an agriculture-related water quality concern, as diseases from micro-organisms in livestock waste can be contracted through direct contact with contaminated water, consumption of contaminated drinking water, and foods, or consumption of contaminated shellfish.

In arid regions such as California's Central Valley, high rates of evaporation and transpiration can cause minerals and salts to accumulate in soils being irrigated. Many of the soils in the Central Valley have soils containing high amounts of clay that cause water containing salts to accumulate in near-surface groundwater near the plant's root zone. To prevent the root zone from becoming water logged and to preserve the soils' productivity, farmers often install underground or sub-surface drainage facilities that improve drainage and allow the farmer to flush excess salts from the soil. These underground drainage systems (also known as tile drains) drain irrigation return waters into adjacent rivers and streams, providing pathways for the contaminants listed above. In addition, storm water runoff can serve to mobilize and transport agricultural-related contaminants, resulting in surface water pollution.

Organization and Elements

The watersheds located in each of the three main surface water basins are listed below. Figures 3-1, 3-2, and 3-3 delineate the boundaries of each watershed within the larger basin.

I. Sacramento River Basin (Figure 3-1)

I.A. Pit River Watershed

I.B. Shasta-Tehama Watershed

I.C. Upper Feather River–Upper Yuba River Watershed

I.D. Colusa Basin Watershed

I.E. Butte-Sutter-Yuba Watershed

I.F. Lake-Napa Watershed

I.G. Solano-Yolo Watershed

I.H. American River Watershed

II. San Joaquin River Basin (Figure 3-2)

II.A. Cosumnes River Watershed

II.B. Delta-Mendota Canal Watershed

II.C. San Joaquin River Watershed

II.D. San Joaquin Valley Floor Watershed

II.E. Delta-Carbona Watershed

II.F. Ahwahnee Watershed

II.G. Mariposa Watershed

II.H. Upper Mokelumne River–Upper Calaveras River Watershed

II.I Merced River Watershed

II.J. North Valley Floor Watershed

II.K. Stanislaus River Watershed

II.L. Tuolumne River Watershed

III. Tulare Lake Basin (Figure 3-3)

III.A. Kings River Watershed

III.B. Kaweah River Watershed

III.C. Kern River Watershed

III.D. South Valley Floor Watershed

III.E. Grapevine Watershed

III.F. Coast Range Watershed

III.G. Fellows Watershed

III.H. Temblor Watershed

III.I. Sunflower Valley Watershed

III.J. Southern Sierra Watershed

The discussion for each watershed includes a description of the watershed's general characteristics, land use patterns, Basin Plan status, hydrology, and surface water quality. The general description of each watershed identifies its boundaries, acreage and square miles, topography, climate, and major water bodies and drainages. For each watershed, a table lists the land use cover types according to DWR data and the California Department of Forestry and Fire Protection (CDF) Fire Resources Assessment Program GIS layer for vegetation (FRAPVEG), as available (see discussion under Land Use Data Collection and Methods for Watershed Boundaries).

The Basin Plan status section lists the beneficial uses identified for each watershed in the water quality control plan for its respective larger basin. In the hydrology discussion, flow information is described for the major water bodies and drainages, as well as those with water quality issues, as available. In the water quality section, a table describes the known agricultural contaminants and conditions that affect water quality in the specific watershed and the affected water bodies, as applicable. The table cites the parameter, the potential sources, and references data that support these conclusions. In addition, the rivers, creeks, and agriculture drains that the table represents are included in the notes at the bottom of the table. Appendix A is a compilation of data collected for analysis of water quality conditions. Appendix B contains summarized flow data for each of the watersheds. Appendix C contains the water quality objectives used to evaluate water quality monitoring data and identify where potential water quality problems exist.

General Sources of Information

Surface Water Quality Data Collection and Methods

Collection of resources and data for surface water quality descriptions was accomplished using various state and federal agency websites, water quality reports from various water quality coalitions, and the *Revised Draft of the 2007 Review of Monitoring Data for the Irrigated Lands Conditional Waiver Program* (*2007 Review of Monitoring Data for ILRP*) (Central Valley Water Board 2007a). U.S. Geological Survey (USGS) Water Resources Investigation Reports also were helpful in providing relevant data sources. Because this existing conditions report covers such a large geographical area, , information to assess a particular watershed often was insufficient and resulted in data gaps.

Many types of data for surface water analysis are available from government agencies (e.g., DWR, USGS, and Reclamation) that routinely measure river flow, temperature, salinity, and a variety of water quality parameters. Different agencies have collected data during various periods, at different stations, and with different parameters. These data are stored in public and private databases that are operated by multiple agencies. Each type of data must be individually downloaded, processed, compiled, and compared.

Each database has different sets of procedures for downloading data. Some databases offer web-based retrieval, and others are stored on a compact disc (CD) (e.g., USGS and EPA). Some databases have interactive maps, while others allow only text or number searches for station names or identification numbers, respectively. Without a map, it is difficult to identify station locations or names without extensive knowledge of each specific area. Some databases are not publicly viewable and must be accessed through individual agency staff. In short, each database has its own accessibility features and constraints. This section identifies the sources of information and the techniques and methods associated with the data collection.

Coalition Data—Central Valley Water Board *2007 Review of Monitoring Data for ILRP*

The Central Valley Water Board summarized the extensive water quality data collected by coalition groups in the *2007 Review of Monitoring Data for ILRP*. The Central Valley Water Board *2007 Review of Monitoring Data for ILRP* is referenced in the following sections instead of each individual coalition. The report presents the first region-wide assessment of data collected for the ILRP since its inception in 2003. Monitoring data were obtained not only from the multiple coalitions but also from individual dischargers, Water Board contracts (Phases I and II) with the University of California, the Surface Water Ambient Monitoring Program (SWAMP), and a small amount of monitoring by Central Valley Water Board staff.

Toxicity tests were conducted in conjunction with surface water column samples. In addition, toxicity identification evaluations (TIEs) were conducted as part of the ILRP monitoring. These are helpful in determining the types of chemicals that are affecting the environment. When TIEs were performed during the ILRP monitoring, it is discussed in each of the relevant sections below.

ILRP monitoring evaluated toxicity in surface water and sediment samples. Toxicity to algae (*Selenastrum capricornutum*), fathead minnow (*Pimephales promelas*), or water flea (*Ceriodaphnia dubia*) indicates surface water contamination and is generally indicative of herbicide, metal, or insecticide contamination. Fecal coliform or *E. coli* is a pathogen indicator in the watershed that is typically associated with several potential sources, including animal confinement and grazing facilities.

Diazinon and chlorpyrifos are organophosphate pesticides historically used for urban and agricultural pest control throughout the Central Valley. Since 2001, however, EPA has mandated the phase-out of diazinon and chlorpyrifos use in urban areas and restrictions for agricultural use. Diazinon and chlorpyrifos both represent contaminants of high TMDL priority. In 2003, the Central Valley Water Board issued Resolution R5-2003-0148, which approved a Basin Plan amendment establishing TMDLs and implementation plans for diazinon in the Sacramento River and Lower Feather River. The Central Valley Water Board completed the diazinon and chlorpyrifos TMDL in September 2004.

California Data Exchange Center

The California Data Exchange Center (CDEC) (http://cdec.water.ca.gov) is maintained by DWR, through the Division of Flood Management. It contains current and historical flow data, physical water quality data, and meteorological datasets for locations throughout California. Users locate individual stations through a user-friendly map interface or by doing a key word search. Once the desired stations are located, a user may download one parameter from one station at a time, and the same limitations apply to downloading 3 or 4 years of hourly or 15-minute data at a time. After the data sequence is displayed on the screen, the user may select to save it to a file, or select a spreadsheet program to open it directly.

CDEC data are considered provisional and require some processing to ensure their accuracy. For example, processing 15-minute data or hourly data into daily and then monthly average data sets includes performing daily counts to ensure that the proper amount of data is included. Once data is in daily format, the data are reviewed to check for outliers. If an outlier is found, the date are checked and the original 15 minute or hourly data set is reviewed to determine whether the outlier is a single problematic data point, or multiple consecutive outliers. Once this is determined, the decision to delete or keep the data point is made. Once the daily data are finished processing, the data can be converted to monthly averages. Note that monthly averages are not representative of flow regimes for some locations due to the intensive daily flashy flows that some drainages may experience during the storm season. Nevertheless, due to the large number of creeks, rivers, and drainages in the Central Valley, the presentation of monthly average flows is the most feasible.

U.S. Geological Survey

The USGS maintains a database of current and historical flow and water quality data from many flow and water quality stations in California. These data can be accessed on the Internet at <http://water.usgs.gov/data.html>, as well as on a CD database product that is updated annually by a commercial vendor (Hydrosphere Data Products). This same vendor has a CD product with the EPA water quality database, called STORET. It is important to note that sometimes data between stations do not cross over between the website and the Hydrosphere product.

The USGS website has current and historical flow and water quality (i.e., grab sample) datasets. Hourly or 15-minute flow, stage, electrical conductivity (EC), and temperature data are available in the real-time portion of the database. Stations can be selected by various descriptors, such as state, station name, identification number (ID), and period of record. Once a station is selected, individual parameters can be saved in a tab-separated file and then opened in a spreadsheet and error-checked. This USGS website is one of the more user-friendly database interface and retrieval systems available.

Bay Delta and Tributaries Project

Like the CDEC, the Bay Delta and Tributaries Project (BDAT) website (http://baydelta.water.ca.gov/index.html) is maintained by DWR. It consists of a database of water quality and meteorological datasets provided by more than 50 organizations. Although a map-based user interface to select data by location is being developed, data locations must currently be specified by location or ID code. This means that the user must already know the locations that are desired. Once a station is selected, the desired parameter(s) can be downloaded as an Excel file and then opened on the user's computer.

Department of Pesticide Regulation Surface Water Database

The Department of Pesticide Regulation maintains a Surface Water Database containing data from a wide variety of environmental monitoring studies designed to test for the presence or absence of pesticides in California surface waters. As part of DPR's effort to provide public access to pesticide information, the DPR maintains a website that provides access to data from DPR's Surface Water Database.

Land Use Data Collection and Methods for Watershed Boundaries

Watershed Boundaries

Watershed boundaries were derived from the California Interagency Watershed Map of 1999 (CalWater 2.2.1). Updated in May 2004, CalWater 2.2.1 is the State of California's working definition of watershed boundaries, beginning with the division of the state's 101 million acres into 10 hydrologic regions (HRs). Each HR is progressively subdivided into six smaller, nested levels: the hydrologic unit (HU—major rivers), hydrologic area (HA—major tributaries), hydrologic sub-area (HSA), super planning watershed (SPWS), and planning watershed (PWS). At the PWS level, where implemented, polygons range in size from approximately 3,000 to 10,000 acres.

With the exception of the Sacramento River Basin, watershed boundaries were derived for the current project by using HU boundaries. Where applicable, hydrologic units were lumped into regions with similar hydrology and land use characteristics. All boundaries in each watershed boundary dataset, including the Sacramento River Basin, were derived from some level of CalWater 2.2.1—whether it was HU, HSA, or PWS.

The San Joaquin River Basin also was derived from CalWater 2.2.1 boundaries. However, some of the watersheds were combined to reduce the amount of redundancy in the delineations. Tulare Lake Basin Watershed boundaries also used CalWater 2.2.1 and were not altered.

Compilation of California Department of Water Resources Spatial Data

Jones & Stokes obtained the most current data available for each county under the jurisdiction of the Central Valley Water Board. Data were downloaded from the DWR Land and Water Use website (http://www.landwateruse.water.ca.gov/basicdata/landuse/digitalsurveys.cfm). For each basin (Sacramento River, San Joaquin River, and Tulare Lake), countywide data were aggregated into one dataset and then checked for matching edges; sliver polygons were repaired where necessary. Slivers were converted to the nearest land use classification where easily discernable. In ambiguous cases, they were classified as native vegetation. These sliver errors at county boundaries accounted for less than 0.035 percent by area within each basin (0.017 percent for the region as a whole).

Supplemental Spatial Data (California Department of Forestry and Fire Protection, Fire Resources Assessment Program Vegetation)

For several counties in the Central Valley Region, DWR land use spatial data are incomplete or unavailable for the higher elevations that generally are located above the major dams. To represent the entire Central Valley Water Board jurisdiction, the DWR land use data have been combined with the CDF FRAP GIS layer (Multi-Source Land Cover Data v02_2) when necessary. This GIS dataset was chosen from many available sources because it has the broadest and most complete coverage of California, as well as having been peer reviewed and well documented. Readers are encouraged to visit the FRAPVEG site (http://frap.cdf.ca.gov/projects/frap_veg/index.html), which has detailed documentation on methods, links to sites with the source data used in FRAPVEG, and an update schedule.

The FRAPVEG dataset uses the California Wildlife Habitat Relationships (CWHR) system classification, which is different from the DWR classification system because it focuses on land cover rather than land use. The main FRAP land use categories are agriculture, urban, and native vegetation. Calculations for irrigated agriculture includes citrus and subtropical; deciduous fruits and nuts; field crops; grain/hay crops; pasture; rice; semi agricultural and incidental agriculture; truck, nursery, and berry crops; vineyards; and agriculture. The “idle” category is excluded from calculating irrigated agriculture.

Urban land use includes urban, urban landscape, urban residential, commercial, and industrial land use categories. The native vegetation land use cover type includes riparian vegetation, annual grassland, conifer, hardwood, herbaceous, shrub, and wetland.

To develop uniform calculations and maps for this report, the FRAPVEG GIS data were reclassified to more closely represent the DWR land use classes. FRAPVEG classifications of conifer, desert, hardwood, herbaceous, and shrub are calculated as native vegetation. Although the DWR land use classifications do not have a wetland category, the FRAPVEG classification of wetland was retained.

Calculations and Statistics of Land Use Data

All calculations were performed using ESRI ArcGIS 9.1. A wide variety of geoprocessing tools were used to compile and analyze the data for this report, including Merge, Intersect, and Erase. All areas were calculated using *Summarize* or *Frequency* on tabular data and converted to appropriate units using Microsoft Excel.

Coordinate System

All spatial data are stored in Geodatabase format using the Teale Albers projection, NAD 1983 datum. For more information on the parameters of this coordinate system, visit <http://gis.ca.gov>.

Data Adequacy/Data Gaps

Where monitoring data are available for water bodies in the Central Valley Region, they are usually adequate to understand where water quality issues from agricultural practices may exist. Most of the data collected in the Central Valley Region that are easily accessible focus attention on a particular problem or area of concern. While not many water quality issues have been identified for undeveloped or non-agricultural areas, there may actually be issues in those areas that have not been detected due to the lack of monitoring. One issue that is apparent in the data is the lack of a long-term record in specific areas. Nevertheless, the data are generally sufficient to understand the water quality concerns that may result from agricultural practices and to understand what may happen as management measures are implemented to deal with identified concerns.

Overview of Agricultural Impacts on Surface Waters of the Central Valley

There are few agricultural impacts on surface waters within the upper watersheds (or watersheds located above storage reservoirs). The majority of agriculture-related impacts on surface waters are located below the major storage reservoirs in the Central Valley.

Assessing the extent and magnitude of agricultural impacts on surface water quality is complex due to the non-point source nature of agricultural runoff. Despite its significant impact on surface water quality, controlling agricultural pollution is a challenge because of the difficulty in cost-effectively monitoring non-point contributors; the volume of water used; and variability related to weather and site-specific characteristics, including soil type, topography, climate, and proximity to the water resource.

To date, Congress has exempted agricultural drainage from regulation under the CWA. However, under the Porter-Cologne Act, the Regional Board can regulate agricultural drainage discharges to surface water bodies. The *Water Quality Control Plan for the Sacramento and San Joaquin River Basins* (Sacramento and San Joaquin Rivers Basin Plan) (Central Valley Water Board 2007b) is the primary policy document describing the legal, technical, and programmatic basis for water quality regulation in the Central Valley. The Basin Plan includes the beneficial uses of each water body in the region; water quality objectives to protect beneficial uses, and implementation plans for achieving water quality objectives.

The significance of water pollutants commonly produced by agriculture is suggested by information on impaired waters provided to EPA in accordance with Section 303(d) of the CWA. Impaired water bodies are waters that do not meet water quality objectives and cannot meet those standards through point-source controls alone. The water quality objectives used to evaluate water quality data and to identify water quality problems for each watershed are included in Appendix C.

In 2003, a monitoring program for irrigated agriculture was initiated to evaluate the effects of irrigated agriculture on Central Valley surface waters. The 2007 review of the first 3 years of monitoring (May 2004 through October 2006) that was conducted for the ILRP (*2007 Review of Monitoring Data for ILRP*) summarizes monitoring information and provides baseline information regarding surface water quality conditions.

In general, the parameters or constituents that were monitored can be categorized as follows:

- toxicity in sediment,

- toxicity in water,
- pesticides,
- metals,
- bacteriological analyses,
- dissolved oxygen (DO) and pH,
- salinity as measured by total dissolved solids and/or EC, and
- nutrients (phosphorus- and nitrogen-containing compounds, including phosphate, nitrate, and ammonia).

The monitoring results then were compared to water quality standards that are listed (numeric water quality standards) or described (narrative water quality standards) in the *Sacramento and San Joaquin Rivers Basin Plan* and the *Water Quality Control Plan for the Tulare Lake Basin* (Tulare Lake Basin Plan).

The watershed descriptions in this section describe the water quality issues related to agriculture in specific watersheds. The site-specific descriptions were based on several data sources that are referenced in the discussions. Some generalizations about water quality revealed through the monitoring are listed below:

Water column toxicity occurred to all species and is widespread in the Central Valley, although the causes of toxicity are not as apparent. The percentage of monitoring locations with toxicity, compared to those without, increased traveling north to south in the Central Valley.

Sediment toxicity occurred in all regions of the Central Valley. Studies conducted by the University of California in the Central Valley strongly suggest that sediment toxicity was caused by pyrethroids, which are replacement pesticides for organophosphates.

Predominant pesticides detected in water throughout the Central Valley monitoring sites include chlorpyrifos, diazinon, simazine, diuron, and DDT/breakdown products. Detections are not necessarily exceedances—some detections exceeded water quality trigger limits, while others did not.

Salinity, as measured by EC, is a concern throughout the Central Valley and most notably in the San Joaquin River Basin. Many areas rely on imported water for irrigation. Information that would clarify how much of the salinity is the result of background, or uncontrollable factors, and how much is contributed by irrigated agriculture is not available and will require additional study. At this time, there is a concerted effort by many state and local agencies to address issues of salinity in the Central Valley. More information regarding Central Valley salinity is available at <http://www.swrcb.ca.gov/centralvalley/water_issues/salinity/index.shtml>.

The presence of pathogen indicators, such as fecal coliform and *E. coli*, are ubiquitous in water samples collected throughout the Central Valley and are frequently measured at levels higher than the EPA recommended criterion for *E. coli*. Not all strains of *E. coli* are pathogenic, but the presence of *E. coli* or fecal coliform is an indicator of fecal contamination. Several coalitions funded a study to determine the sources of *E. coli* contamination. Part of the study was conducted in the San Joaquin Valley during August and September 2006. A similar study was conducted in the Sacramento Valley during winter and spring 2007. The University of California conducted these studies, which characterize the source type through DNA analyses. Because these studies were limited both spatially and temporally and the methodology is not well-established, further E. coli source investigations will be needed.

I. SACRAMENTO RIVER BASIN

Introduction

The **Sacramento River Basin** contains the entire drainage area of the Sacramento River and its tributaries, from the northeast corner of California to Sacramento County (see Figure 3-1 for watershed boundaries). The basin drains approximately one-third of total runoff in the state into the middle and lower reaches of the Sacramento River. For the purposes of this analysis, the Sacramento River Basin includes eight watersheds: the (A) Pit River, (B) Shasta-Tehama, (C) Butte-Sutter-Yuba, (D) Upper Feather River–Upper Yuba River, (E) Lake-Napa, (F) Colusa Basin, (G) Solano-Yolo, and (H) American River Watersheds (Figure 3-1).

Geologic provinces composing the Sacramento River Basin include the Sacramento Valley, the Coast Ranges, the Klamath Mountains, the Cascade Range, the Sierra Nevada, the Modoc Plateau, and the delta of the Sacramento River. Land uses in the Sacramento River Basin are principally forest and range lands in the upper reaches, with urban development focused around the City of Sacramento. Agriculture is the dominant land use on the valley floor, followed by urban development.

The Sacramento River Basin encompasses approximately 12.2 million acres. Of this amount, 2.4 million acres are classified as agricultural lands. The majority of these irrigated acres occur on the Valley floor, in the Solano-Yolo, Colusa Basin, and Butte-Sutter-Yuba Watersheds. Rice is the primary crop in the Sacramento River Basin, particularly in the Colusa and Butte-Sutter-Yuba Watersheds where poorly drained soils provide ideal conditions. Other predominant crop types include field crops, orchards, pasture, and grains.

Agricultural land uses account for less than 10 percent of total acreage in the Pit River, Shasta-Tehama, Upper Feather River–Upper Yuba River, American River, and Lake-Napa Watersheds.

Overview of Agricultural Impacts on Surface Water in the Sacramento River Basin

In general, agricultural operations have a greater impact on surface water in the Central Valley area around the Sacramento River than in the higher surrounding elevations of the Coast Ranges and Sierra Nevada. This is primarily due to the rich fertile valley topography allowing for much larger agricultural operations.

Water quality concerns in the Sacramento River Basin are concentrated in the Sacramento Valley, in watersheds that are heavily agricultural. These include the Solano-Yolo, Colusa Basin, Butte-Sutter-Yuba Watersheds where agricultural land uses constitute 60, 37, and 36 percent of total acreage, respectively. Section 303(d) listings related to irrigated agriculture occur in all of these watersheds, as well as in the American River Watershed.

While some water bodies in other watersheds of the Sacramento River Basin are also 303(d) listed as impaired, these sources of impairment likely are caused by timber harvesting, grazing, and resource extraction, not irrigated agriculture. Elevated levels of diazinon in the Shasta-Tehama Watershed are related to pesticide use; however, water quality in this watershed generally meets or exceeds water quality objectives. To date, there is no associated Section 303(d) listing.

Surface water quality in the Solano-Yolo, Colusa Basin, Butte-Sutter-Yuba, and American River Watersheds is described in more detail below.

The **Solano-Yolo Watershed** lies west of the Sacramento metropolitan area and follows the Sacramento River to the Delta near Suisun Bay. More than half of the watershed is in agricultural production. Within the watershed, the Lower Sacramento River and Lower Putah and Lower Cache Creeks are listed as impaired for diazinon, which is directly related to the practice of irrigated agriculture.

The **Colusa Basin Watershed** is located northwest of Sacramento on the west side of the Sacramento River. Soils in the watershed are well suited to agriculture, and drainage patterns in the watershed have been extensively altered by agricultural development. The watershed includes the Colusa Basin Drain, which flows with irrigation tailwater year-round and is the single largest source of agricultural return flows to the Sacramento River. A total of 49 miles of the Colusa Basin Drain are listed as impaired due to multiple chemicals, including azinphos-methyl, carbofuran, diazinon, Group A pesticides, malathion, methyl parathion, and molinate/ordram. A TMDL for diazinon and chlorpyrifos, associated with dormant spraying of fruit and nut orchards was adopted for the Sacramento and Feather Rivers in 2007.

The **Butte-Sutter-Yuba Watershed** spans from the eastern Sierra Nevada foothills west to the Sacramento River. Multiple water bodies within the watershed are listed as impaired by sources related to agriculture, including diazinon, chlorpyrifos, and Group A Pesticides. These include Butte Slough and the Lower Bear, Lower Feather, and Sacramento Rivers.

The headwaters of the **American River Watershed** originate east of Sacramento in the Sierra Nevada foothills. The watershed borders the Tahoe Basin on the east and extends west toward Sacramento. It includes the North, Middle, and South Forks of the American River. Agriculture comprises approximately 10 percent of land use in the American River watershed.

While the upper American River Watershed is primarily undeveloped, the lower watershed is dominated by the Sacramento metropolitan area and adjacent agricultural land uses. Land uses in the lower watershed generate both point-source and nonpoint-source discharges that contribute pollutants to surface waters. Therefore water quality conditions in the lower watershed are affected by a combination of urban, industrial, and agricultural land uses.

The lower American River Watershed includes the Natomas East Main Drain Canal, which drains approximately 180 square miles of the Sacramento metropolitan area. Portions of the canal are listed as impaired by chlorpyrifos, diazinon, and polychlorinated biphenyls (PCBs). The sources of these impairments include agricultural pesticides, urban runoff, storm water runoff, and industrial point sources.

A detailed analysis of the impacts on surface water in the Sacramento River Basin is broken up by watersheds and described below.

I.A Pit River Watershed

General Description

The Pit River Watershed is located in northeastern California and is bounded on the west by the Trinity Mountains, on the east by the Warner Mountains, to the north by the Oregon border, and to the south by Shasta Lake and the Lassen National Forest (Figure 3-1). The watershed encompasses approximately 3,008,012 acres (4,700 square miles) (Reclamation 2003). The general topography of the watershed varies significantly, ranging from the lower elevations of the Fall River Valley, to 9,892 feet in the rugged Warner Mountains, to 14,162 feet atop Mount Shasta (SVWQC 2004). The McCloud River and the Sacramento River also are located in the Pit River Watershed; they make up the North and Middle Forks of Lake Shasta. Figure 3-4 illustrates the entire Pit River Watershed and all of the major water bodies in the watershed.

Average annual temperatures in the watershed range from a low of approximately 30ºF to a high of over 100ºF. While summertime maximum temperatures can exceed 100ºF, temperatures are more commonly from 90 to 100ºF. Typically, the last frost occurs in May and the first frost occurs in September.

Land Use Patterns

More than 95 percent of the Pit River Watershed is classified as native vegetation (Figure 3-12), reflecting the presence of Modoc National Wildlife Refuge (NWR) in the northern part of the watershed, a state-owned wildlife area (Ash Creek) in the middle portion, and an additional state-owned reserve (Ahjumawi Lava Springs State Park) in the southwest portion of the watershed (SVWQC 2004). The Pit River and Fall River Watersheds contain nearly all of the irrigated land use in the watershed, with virtually no irrigated land in the McCloud River and Upper Sacramento River Watersheds. Irrigated agriculture represents less than 4 percent of the total land use in the watershed. Table 3-1 contains land use acreage according to DWR land use data for the Pit River Watershed.

Table 3-1. Land Use Acreage according to DWR Land Use Data for the Pit River Watershed

DWR Land Use Type	Acres	Percent Total
Agriculture		
Rice	6,673	0.2
Deciduous Fruits and Nuts	138	0.0
Field Crops	1,025	0.0
Grain and Hay	17,018	0.4
Pasture	132,717	3.0
Truck, Nursery, and Berry Crops	989	0.0
Idle	15,998	0.4
Semi agricultural and Incidental	2,524	0.1
Subtotal	177,082	4.0

DWR Land Use Type	Acres	Percent Total
Urban		
Urban—Unclassified	3,348	0.1
Urban Landscape	514	0.0
Urban Residential	9,388	0.2
Commercial	1,763	0.0
Industrial	1,726	0.0
Vacant	1,291	0.0
Subtotal	18,030	0.4
Native		
Native Vegetation	4,102,190	91.8
Barren and Wasteland	381	0.0
Riparian Vegetation	23,149	0.5
Water Surface	146,018	3.3
Subtotal	4,271,738	95.6
Total	**4,466,849**	**100.0**

Basin Plan Status

The Sacramento and San Joaquin Rivers Basin Plan (Central Valley Water Board 2007b) describes beneficial uses for waters in the Pit River Watershed. Table 3-2 lists the beneficial uses of Goose Lake, the Pit River, the Fall River, the McCloud River, and the Sacramento River (to Box Canyon).

Hydrology

Pit River

Drainage in the Pit River portion of the watershed originates with the North and South Forks (Figure 3-4). The North Fork historically originated at Goose Lake, which is now an enclosed basin. Water from Goose Lake has not spilled into the North Fork Pit River for over 100 years. The South Fork and its tributaries originate in the southern Warner Mountains and Moon Lake in Lassen County. The North and South Forks of the Pit River converge in the town of Alturas in Modoc County and then flow in a southwesterly direction into Shasta Lake in Shasta County (SVWQC 2004). The Fall River is a major tributary to the main Pit River, entering at Fall River Mills upstream of Lake Shasta. In addition to the Fall River, there are many small tributaries to the Pit River. Water quality in these smaller tributaries has not been assessed, and the Pit River is considered representative of the entire Pit River portion of the watershed.

The USGS currently maintains six gauging stations in the Pit River watershed, including a site on the South Fork of the Pit River near Likely (USGS 11345500) and the mainstem of the Pit River near Canby (USGS 11348500). Real time data are available at the Likely and Canby Stations, and they are the two stations used for flow information for the Pit River Watershed.

Average annual flow at the Likely Station between 1929 and 2005 was 49.5 cubic feet per second (cfs), and average annual flow at the Canby Station between 1932 and 2001 was 257 cfs (USGS 2005e). A longer period of record was not used because of recent changes in flow associated with agriculture and other diversions. See Table B-1 in Appendix B for monthly average flows for the Pit River.

Table 3-2. Beneficial Uses in the Pit River Watershed

Beneficial Uses	Goose Lake	Pit River	Fall River	McCloud River	Sacramento River (to Box Canyon)
Municipal and Domestic		E	E	E	
Irrigation	E	E	E		E
Stock Watering	E	E	E		E
Process					
Service Supply					
POW (Power)			E	E	
Rec-1*	E	E, P	E	E, P	E
Rec-2*	E	E	E	E	E
Freshwater Habitat—Warm	E	E	E		
Freshwater Habitat—Cold	E	E	E	E	E
Migration—Warm					
Migration—Cold					
Spawning—Warm		E			
Spawning—Cold		E		E	
Wildlife Habitat	E	E	E	E	E
Navigation					

P = Potential, E = Existing.

* Rec-1 indicates recreational activities involving body contact with water, where ingestion of the water is reasonably possible. These uses include, but are not limited to, swimming, wading, water skiing, skin and scuba diving, surfing, white water activities, fishing, and use of natural hot springs. Rec-2 indicates recreational activities involving proximity to water, but generally with no body contact with water or any likelihood of ingestion of water. These include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, and aesthetic enjoyment associated with the above activities.

Source: Central Valley Water Board 2007b.

USGS also has collected flow data for the Fall River; however, the most complete record started in 1958 and stopped in 1967 (USGS Station 11353700). The calculated annual average flow is 483 cfs (USGS 2005e). This USGS flow gauge is close to the headwaters and is not representative of the entire Fall River flow. No better record is available.

McCloud River

The McCloud River originates above Lake McCloud in Siskiyou County and flows southwesterly for approximately 50 miles until its terminus at Lake Shasta (LMRWA 1998).The McCloud River is the dominant hydrologic feature in the McCloud Watershed and drains the steep, mountainous terrain between Lake McCloud and Lake Shasta. The Pit River Hydroelectric Project Dam at Lake McCloud regulates stream flow into the river to maintain minimum flows for fish habitat (LMRWA 1998). A portion of the McCloud River is diverted from this facility to the Pit River for power generation. See Table B-1 in Appendix B for flow data for the McCloud River above Lake Shasta.

Sacramento River

The Sacramento River headwaters originate on the southwestern slopes of Mount Shasta and the Trinity and Klamath Mountains. There are approximately 40 river miles between the headwaters at Box Canyon Dam and Lake Shasta (DOI 2003). Flow data at Sacramento River above Lake Shasta (CDEC Station DLT) were used because this is the farthest downstream location prior to the river's confluence with Lake Shasta and is considered representative of the flow for the entire Upper Sacramento River Basin. As shown in Table B-1 in Appendix B, monthly average flows from 1995 to 2004 range from a low of 203 cfs during summer to a high of 7,188 cfs during winter.

Water Quality

The Pit River is listed on the 2006 Section 303(d) list as impaired for nutrients, organic enrichment/low DO, and temperature; while the Fall River is listed as impaired for sedimentation/siltation. Sedimentation and siltation can be a result of management practices, such as timber harvesting, or a result of a catastrophic wildfire. In addition, high magnitude flows of relatively short durations may disturb and re-suspend sediment, resulting in a higher turbidity.

In general, the available data indicate that the Pit River Watershed experiences little impact from irrigated agriculture. However, there are a few water quality concerns in the watershed. Appendix C contains the water quality objectives used to identify the water quality concerns listed in Table 3-3.

A water quality investigation conducted by the Regional Board in the Pit River during 2001 and 2002 indicated that temperature was above and DO was below the criteria water quality objectives. The Regional Board collected data from eight locations between the headwaters of the Pit River and Pittville and found that 2001 and 2002 flows were far lower than the historical average. In addition, results at every station except one indicated that temperatures exceeded tolerance levels for coldwater species. Table 3-3 cites potential sources related to the water quality concerns in the Pit River. Factors contributing to elevated temperature are still under investigation.

Elevated levels of bacteria have been found in the Pit River. The likely sources of bacteria are animal confinement facilities and grazing lands. Algae toxicity was also found in the Pit River. Toxicity identification evaluation (TIE) indicates that toxicity to algae is generally indicative of herbicide or metal contamination. Since no metals were detected in the Pit River, the toxicity could have resulted from an herbicide (Central Valley Water Board 2007a).

Table 3-3. Known Agricultural Contaminants and Conditions That Affect Water Quality in the Pit River Watershed

Parameter	Potential Agricultural Sources/Contribution to Water Quality Impairment	Sources
Temperature	Factors contributing to elevated temperature are under investigation.	2
DO	Factors contributing to low DO are under investigation. Nutrient loads from irrigated lands and animal grazing may be connected to low DO.	2
Bacteria	Likely a result of animal confinement facilities land application of waste.	1
Toxicity (algae)	Toxicity to algae is generally indicative of herbicide or metal toxicity but has not been proven in this area.	1

Sources:
[1] Central Valley Water Board 2007a.
[2] USGS 2005c.

I.B Shasta-Tehama Watershed

General Description

The Shasta-Tehama Watershed is located in the far northern portion of the Sacramento River Basin (Figure 3-1), and encompasses approximately 2,925,162 acres (4,571 square miles). The northern boundary of the Shasta-Tehama Watershed abuts Lake Shasta and the Pit River Watershed to the north and east. Trinity County lies west of the watershed, and Glenn and Butte Counties border the watershed to the south and southwest. The general topography of the watershed ranges from approximately 6,000 feet elevation in the southwest portion of the watershed to approximately 150 feet around the Sacramento River area in the southern portion. The watershed shares a relatively small boundary with Plumas County on the east. Figure 3-5 delineates the entire boundary of the Shasta-Tehama Watershed.

The Sacramento River flows from north to south through the center of the Shasta-Tehama Watershed, from the base of Shasta Dam south to the Butte County line and beyond. The Sacramento River has numerous tributaries on each side of the valley floor. The major west side tributaries to the Sacramento River below Shasta Dam include Lower Clear Creek, Cottonwood Creek, Reeds Creek, Red Bank Creek, Elder Creek, and Thomes Creek. The major east side tributaries to the Sacramento River below Shasta Dam include Cow Creek, Battle Creek, Antelope Creek, Mill Creek, and Deer Creek. All of these tributaries located in the Shasta-Tehama Watershed drain naturally to the Sacramento River.

Annual average precipitation in the entire Sacramento River Basin is 36 inches and varies considerably from approximately 20 inches in the valley floor falling exclusively as rain to a range of 40–60 inches annually as rain and snow at higher elevations in the mountains.

The Shasta-Tehama Watershed contains several irrigation districts that supply surface water to agricultural users; including the Anderson-Cottonwood Irrigation District (ACID) based in Anderson and the Tehama-Colusa Canal Authority (TCCA) based in Red Bluff.

Land Use Patterns

The majority (about 89 percent) of land use in the Shasta-Tehama Watershed is categorized as native vegetation by DWR (Figure 3-13). Irrigated agriculture comprises approximately 8 percent of land use for the entire Shasta-Tehama Watershed. The majority of irrigated agriculture in the watershed consists of two crops: pastureland and deciduous fruits and nuts. However, not all pastureland in the Shasta-Tehama Watershed may actually be irrigated. DWR land use data for the Shasta-Tehama Watershed are summarized in Table 3-4.

Table 3-4. Land Use Acreage according to DWR Land Use Data for the Shasta-Tehama Watershed

DWR Land Use Type	Acres	Percent Total
Agriculture		
Citrus and Subtropical	20,728	0.7
Deciduous Fruits and Nuts	82,427	2.8
Field Crops	10,020	0.3
Grain and Hay	20,836	0.7
Idle	12,256	0.4
Pasture	63,648	2.2
Rice	2,746	0.1
Semi agricultural and Incidental	4,502	0.2
Truck, Nursery, and Berry Crops	1,502	0.1
Vineyards	189	0.0
Subtotal	218,854	7.5
Urban		
Urban—Unclassified	18,177	0.6
Urban Landscape	1,438	0.1
Urban Residential	66,799	2.3
Commercial	3,280	0.1
Industrial	5,617	0.2
Vacant	8,979	0.3
Subtotal	104,290	3.6
Native		
Native Vegetation	2,586,054	88.4
Barren and Wasteland	7,608	0.3
Riparian Vegetation	18,089	0.6
Water Surface	18,602	0.6
Subtotal	2,630,353	89.9
Total	**2,925,162**	**100.0**

Basin Plan Status

The Sacramento and San Joaquin Rivers Basin Plan (Central Valley Water Board 2007b) describes beneficial uses for waters in the Shasta-Tehama Watershed. Table 3-5 lists the beneficial uses of Lower Clear Creek (below Whiskeytown Reservoir), Cow Creek, Battle Creek, Cottonwood Creek, Antelope Creek, Mill Creek, Thomes Creek, and Deer Creek.

Table 3-5. Beneficial Uses in the Shasta-Tehama Watershed

	Municipal & Domestic	Irrigation	Stock Watering	Process (Industrial)	Service Supply	POW (Power)	Rec-1*	Rec-2*	Freshwater Habitat—Warm	Freshwater Habitat—Cold	Migration—Warm	Migration—Cold	Spawning—Warm	Spawning—Cold	Wildlife Habitat	Navigation
Clear Creek below Whiskeytown Reservoir	E	E	E				E	E	E	E		E	E	E	E	
Cow Creek	P	E	E			E	E	E		E		E	E	E	E	
Battle Creek		E	E			E	E	E	E	E		E	E	E	E	
Cottonwood Creek	E	E	E	P	P	P	E	E	E	E		E	E	E	E	
Antelope Creek	E	E	E				E	E	E	E		E	E	E	E	
Mill Creek	E	E	E				E		E	E		E	E	E	E	
Thomes Creek		E	E			P	E	E	E	E		E	E	E	E	
Deer Creek	E	E	E				E	E	E	E		E	E	E	E	

P = Potential, E = Existing.

* Rec-1 indicates recreational activities involving body contact with water, where ingestion of the water is reasonably possible. These uses include, but are not limited to, swimming, wading, water skiing, skin and scuba diving, surfing, white water activities, fishing, and use of natural hot springs. Rec-2 indicates recreational activities involving proximity to water, but generally with no body contact with water or any likelihood of ingestion of water. These include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, and aesthetic enjoyment associated with the above activities.

Source: Central Valley Water Board 2007b.

Hydrology

Lake Shasta

Sacramento River flows are largely controlled by the CVP storage and diversion facilities operated by Reclamation. Shasta Dam, located 12 miles upstream of Redding, forms Lake Shasta, the dominant reservoir on the mainstem of the Sacramento River. The principal rivers that flow into Lake Shasta are the Upper Sacramento River, the Pit River, and the McCloud River. Combined, these rivers drain a 6,665-square-mile drainage area above Lake Shasta. When Lake Shasta is full, it has storage capacity of approximately 29,500 acre-feet of water and 270 miles of shoreline.

Sacramento River

Stream flow patterns in the Sacramento River reflect a combination of natural runoff events and operational controls. Monthly average flows for the Sacramento River at Red Bluff are shown in

Table B-2 in Appendix B. In general, natural Sacramento River stream flow patterns are distinctly seasonal; however, managed reservoir releases have altered the natural flow regimes in recent history. A typical water year (starting on October 1) begins with low natural runoff flows, initiates reduced reservoir releases as the agricultural irrigation season ends, and includes minimum reservoir storage levels in preparation for winter inflows. With the return of winter rains, reservoir inflows and river flows increase exponentially. River flows and reservoir inflows are sometimes reduced slightly in late winter before the peak periods of mountain snowmelt that occur in spring. The irrigation season in the Central Valley typically begins around April 15, and river flows steadily increase through the summer as reservoirs are lowered (primarily Shasta Lake) for hydropower production and to meet agricultural irrigation demands of the Sacramento Valley, as well as to meet CVP operational demands and requirements.

Water Diversion Facilities

Water is released from Lake Shasta into the Lower Sacramento River at Shasta Dam, 9 miles upstream of Keswick Dam. Keswick Dam forms Keswick Reservoir, a regulating reservoir for Shasta Dam. There are two significant water diversions on the Sacramento River below Keswick Dam in the Shasta-Tehama Watershed: the ACID diversion located in Redding and the Red Bluff Diversion Dam (RBDD) located just south of the town of Red Bluff. ACID diverts water from a seasonal dam in the Sacramento River to gravity-feed a 39-mile irrigation canal that meanders south of Redding, primarily supplying pasturelands and a small amount of croplands in Anderson and Cottonwood. The RBDD was built by Reclamation in the mid 1960s and spans the width of the Sacramento River with 11, 60-foot-wide spillway gates. When the spillway gates are lowered during the irrigation season, the diversion dam raises the level of the Sacramento River by 17 feet upstream of the dam. This hydraulic head in turn allows TCCA to gravity-feed water deliveries to the Corning Canal and the Tehama-Colusa Canal. The Corning Canal is 15 miles long and serves three water districts, while the Tehama-Colusa Canal is 110 miles long and serves 14 water districts. TCCA annually supplies approximately 660,000 acre-feet of water to 200,000 irrigated acres along the west side of the Sacramento Valley in Tehama, Glenn, and Yolo Counties.

West Side and East Side Tributaries

As described earlier, the Sacramento River has numerous tributaries on each side of the valley floor. The major west side tributaries to the Sacramento River below Shasta Dam include Lower Clear Creek, Cottonwood Creek, Reeds Creek, Red Bank Creek, Elder Creek, and Thomes Creek. The major east side tributaries to the Sacramento River below Shasta Dam include Cow Creek, Battle Creek, Antelope Creek, Mill Creek, and Deer Creek. Table B-2 in Appendix B shows monthly average flows from 1995 to 2004 for Lower Clear Creek, Cow Creek, Mill Creek, Deer Creek, Cottonwood Creek, Elder Creek, and the Sacramento River at Red Bluff.

Clear Creek is one of the first major west side tributaries to the Sacramento River. Clear Creek begins in the Trinity Mountains and flows 35 miles to its confluence with the Sacramento River near Redding. Water is also diverted from the Trinity River to Clear Creek through the Clear Creek Tunnel to serve agricultural and municipal demands in the San Joaquin Valley as part of the CVP. The USGS monitors flows in Lower Clear Creek near Igo, as shown in Table B-2 in Appendix B.

Cottonwood Creek is the next major west side tributary to the Sacramento River. The headwaters of Cottonwood Creek originate on the eastern slopes of the North Coast Range, as well as the southern slopes of the Trinity Mountains. Cottonwood Creek flows eastward through the valley floor toward the Sacramento River, the confluence lying approximately 16 miles north of Red Bluff. The watershed has three main tributaries: the North Fork, the Middle Fork, and the South Fork. The Cottonwood Creek Watershed drains approximately 938 square miles, and has an approximate annual runoff of 586,000 acre-feet. Monthly average flows for Cottonwood Creek are shown in Table B-2 in Appendix B.

Several additional west side tributaries located south of Cottonwood Creek include Reeds Creek, Red Bank Creek, Elder Creek, and Thomes Creek. Flow data are limited for Thomes Creek and Red Bank Creek, and there are no known flow monitoring stations for Reeds Creek. The average annual flow from 1960 to 1982 for Red Bank Creek near Red Bluff (11378800) was 35,260 cfs. The USGS monitored flows on Thomes Creek from 1920 until 1996. The annual average flow from 1920 to 1996 on Thomes Creek (11382000) was 292 cfs. Additional flow monitoring information for Elder Creek is included in Table B-2 in Appendix B.

Cow Creek is one of the first major east side tributaries downstream of Lake Shasta. The Cow Creek Watershed encompasses over 425 square miles (approximately 275,000 acres). There are eight hydroelectric facilities in the Cow Creek Watershed operated by private entities and more than 190 irrigation diversions in the Cow Creek Watershed (DOI 2003). Monthly average flows for Cow Creek are shown in Table B-2 in Appendix B.

The Battle Creek Watershed is situated on the volcanic slopes of Mt. Lassen in southeastern Shasta and northeastern Tehama Counties. PG&E owns and operates several hydropower facilities and water diversions throughout the Battle Creek Watershed. In addition, the Coleman National Fish Hatchery, the largest Chinook salmon fish hatchery in the world, is located near the mouth of Battle Creek and operated by USFWS (DOI 2003). Because limited flow records for Battle Creek are available from USGS, monthly average flows for Battle Creek are not included in Appendix B. However, historical annual average Battle Creek flow below the Coleman National Fish Hatchery from 1962 to 1983 was 528 cfs **(**USGS 2005e**)**.

Antelope Creek is the next major east side tributary south of Battle Creek. Antelope Creek flows southwest from the foothills of the Cascade Range and enters the Sacramento River 9 miles southeast of the town of Red Bluff. The Antelope Creek drainage is approximately 78,720 acres (123 square miles), and the average stream discharge is 107,200 acre-feet per year. USGS monitored flows at Antelope Creek near Red Bluff (11379000) from 1949 to 1982; the annual average flow was 150 cfs.

Mill Creek is another east side tributary located south of Antelope Creek. Mill Creek originates from the southern slopes of Lassen Peak in Lassen Volcanic National Park and receives inflow from snowmelt, rainfall, and groundwater infiltration. USGS monitors flows on Mill Creek near Los Molinos. Monthly average flows for Mill Creek are shown in Table B-2 in Appendix B.

Deer Creek is the next east side tributary located south of Mill Creek. Its drainage area is approximately 133,120 acres. USGS monitors flows on Deer Creek near Vina (11383500). Monthly average flows for Deer Creek are shown in Table B-2 in Appendix B.

Water Quality

Generally, water quality in the Shasta-Tehama Watershed meets or exceeds the water quality objectives in the Sacramento and San Joaquin Rivers Basin Plan (Central Valley Water Board 2007b). Water bodies in the Shasta-Tehama Watershed that are impacted from fecal coliform or *E. coli* include Clover Creek, Oak Run Creek, South Cow Creek, Anderson Creek, and Burch Creek. Water bodies impacted by diazinon include the Sacramento River and Burch Creek. Table 3-6 identifies the known agricultural contaminants that affect water quality in the Shasta-Tehama Watershed. Appendix C contains the water quality objectives used to identify the water quality concerns listed in the table.

Water quality monitoring results that indicated statistically significant toxicity to *Selenastrum capricornutum* (algal species) included several locations in the Shasta-Tehama Watershed, including on Burch Creek, Antelope Creek, and China Slough. Burch Creek (at Woodson Bridge) also had multiple toxic results for *Ceriodaphnia* (water flea) and one measured value of diazinon above the Sacramento and San Joaquin Rivers Basin Plan objective.

The 2006 Section 303(d) list divides the Sacramento River into four sections—Keswick Dam to Cottonwood Creek, Cottonwood Creek to Red Bluff, Red Bluff to Knights Landing, and Knights Landing to the Delta. All four sections of the Sacramento River are listed on the Section 303(d) list for unknown toxicity.

Table 3-6. Known Agricultural Contaminants and Conditions That Affect Water Quality in the Shasta-Tehama Watershed

Parameter	Potential Agricultural Sources/Contribution to Water Quality Impairment	Sources
Bacteria (fecal coliform/*E. coli*)	Agriculture, grazing, or other sources	1, 2
Diazinon	Pesticide use	2, 3
Unknown toxicity	Unknown source	1, 2

Sources:

[1] 2006 Section 303(d) list.

[2] Central Valley Water Board 2007a.

[3] Central Valley Water Board 2007c.

Note: Water bodies in the Shasta-Tehama Watershed that are impacted from fecal coliform or *E. coli* include Clover Creek, Oak Run Creek, South Cow Creek, Anderson Creek, and Burch Creek. Water bodies impacted by diazinon include the Sacramento River and Burch Creek. Water bodies impacted by unknown toxicity include the Sacramento River.

I.C Upper Feather River–Upper Yuba River Watershed

General Description

The Upper Feather River–Upper Yuba River watershed is located in the foothills and mountains of the northern Sierra Nevada and encompasses 2,062,080 acres (3,222 square miles) (Figure 3-1). The watershed borders Placer County and the American River Watershed to the south. Lassen County forms a majority of the watershed boundary to the east and the northeast. The Butte-Sutter-Yuba watershed forms the western boundary. Figure 3-6 depicts the entire Upper Feather River–Upper Yuba River watershed. The general topography of the watershed ranges from approximately 6,774 feet elevation in the northern portion of the watershed to approximately 1,000 feet east of Lake Oroville. The major rivers in this watershed include the North Fork Feather River, Middle Fork Feather River, South Fork Feather River, North Yuba River, Middle Yuba River, Yuba River, and Bear River. Frenchman Reservoir is on the Feather River and Englebright Reservoir on the Yuba River.

Precipitation in this watershed ranges from 69.7 inches in the west to less than 12.2 inches in the east. This difference can be attributed to storm systems from the Central Valley, which move from west to east and deposit the majority of their precipitation along the west slope of the Sierra Nevada (SVWQC 2004).

Land Use Patterns

DWR classifies approximately 94 percent of the land use in the Upper Feather River–Upper Yuba River watershed as native vegetation (Figure 3-14). The entire watershed is relatively rural; urbanization constitutes just over 1 percent of the entire watershed.

Table 3-7 contains acreage according to DWR and FRAP land use data for the Upper Feather River–Upper Yuba River Watershed. Agriculture makes up only a small portion of the watershed, totaling 2.4 percent of land use; of this amount, 2.1 percent includes pasturelands in the vicinity of the Sierra Valley and the Indian Valley.

Table 3-7. Land Use Acreage according to DWR and FRAP Land Use Data for the Upper Feather River–Upper Yuba River Watershed

Land Use	Acres	Percent Total
DWR Land Use Type		
Agriculture		
Deciduous Fruits and Nuts	58	0.0
Grain and Hay Crops	2,044	0.1
Idle	1,330	0.0
Pasture	64,100	2.1
Rice	7	0.0
Semi agricultural and Incidental	785	0.0
Truck, Nursery, and Berry Crops	468	0.0
Subtotal	68,790	2.3

Land Use	Acres	Percent Total
Urban		
Urban—Unclassified	2,333	0.1
Urban Residential	10,121	0.3
Urban Landscape	939	0.0
Commercial	2,445	0.1
Industrial	1,427	0.0
Vacant	1,114	0.0
Subtotal	18,380	0.6
Native		
Native Vegetation	2,368,492	78.1
Barren and Wasteland	230	0.0
Riparian Vegetation	29,379	1.0
Water Surface	53,776	1.8
Subtotal	2,451,877	80.8
FRAP Land Use Type		
Agriculture	5,082	0.2
Barren	19,716	0.7
Conifer	275,875	9.1
Hardwood	115,684	3.8
Herbaceous	26,702	0.9
Shrub	24,213	0.8
Urban	18,017	0.6
Water	7,512	0.2
Wetland	1,734	0.1
Subtotal	494,534	16.3
Total	**3,033,583**	**100**

Basin Plan Status

The Sacramento and San Joaquin Rivers Basin Plan (Central Valley Water Board 2007b) describes beneficial uses of waters in the Upper Feather River–Upper Yuba River Watershed. Table 3-8 lists the beneficial uses for the North Fork Feather River, Middle Fork Feather River, Yuba River, and Bear River.

Table 3-8. Beneficial Uses in the Upper Feather River–Upper Yuba River Watershed

		Middle Fork Feather River					Yuba River		
Beneficial Uses	North Fork Feather River	Source to Little Last Chance Creek	Frenchman Reservoir	Little Last Chance Creek to Lake Oroville	Lake Davis	Lakes Basin Lakes	Sources to Englebright Reservoir	Englebright Dam to Feather River	Bear River
Municipal & Domestic	E						E		E
Irrigation		E					E	E	E
Stock Watering		E					E	E	E
Process									
Service Supply								E	
POW (Power)	E						E	E	E
Rec-1*	E	E	E				E	E	E
Rec-2*	E	E	E				E	E	E
Freshwater Habitat—Warm		E	P					E	E
Freshwater Habitat—Cold	E	E	E				E	E	E
Migration—Warm								E	P
Migration—Cold								E	P
Spawning—Warm								E	P
Spawning—Cold	E	E	E				E	E	E
Wildlife Habitat	E	E	E				E	E	
Navigation									

P = Potential, E = Existing.

* Rec-1 indicates recreational activities involving body contact with water, where ingestion of the water is reasonably possible. These uses include, but are not limited to, swimming, wading, water skiing, skin and scuba diving, surfing, white water activities, fishing, and use of natural hot springs. Rec-2 indicates recreational activities involving proximity to water, but generally with no body contact with water or any likelihood of ingestion of water. These include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, and aesthetic enjoyment associated with the above activities.

Source: Central Valley Water Board 2007b.

Hydrology

Upper Feather River

The Upper Feather River Watershed includes 2,062,080 acres of land that drains west from the northern Sierra Nevada into the Sacramento River. The Feather River is considered unique because the North and Middle Forks originate east of the Sierra Nevada in the Diamond Mountains, and as these two forks flow west, they breach the crest of the Sierra Nevada (SVWQC 2004).

The Middle Fork of the Upper Feather River receives flow from Dolly Creek and Little Grizzly Creek. The USGS website does not have flow data for Dolly Creek but does contain flow data for Little Grizzly Creek from 1964 to 1979. The annual average flow from 1964 to 1979 for Little Grizzly Creek was 48 cfs. The USGS website does not contain flow data for any of the upper arms of the Feather River. Table B-3 in Appendix B shows monthly average flows for the Feather River at Oroville from 1995 to 2004.

Yuba River

The North Upper Yuba River feeds New Bullards Bar Reservoir. The Middle and South Yuba River merge above the Englebright Reservoir, a small reservoir located downstream of New Bullards Bar Reservoir. Englebright Reservoir is part of the Butte-Sutter-Yuba Watershed and is addressed in that section. The CDEC website monitors flow on the North Yuba River, the Middle Yuba River, and the South Yuba River. The North Yuba River flows are measured below the New Bullards Bar Dam. The Middle Yuba River flows are measured just before the confluence with the North Yuba River at Our House Dam. Here, the South Yuba River merges with the North and Middle Yuba River and flows are measured at Jones Bar. The South Yuba River has multiple tributaries, including Humbug Creek, Kanaka Creek, and Deer Creek, which are all listed on the 2006 Section 303(d) list for various non-agricultural pollutants. The USGS website and the CDEC website do not show any flow stations on either of these tributaries. Monthly average flow information for the three forks of the Yuba River is shown in Table B-3 in Appendix B.

Bear River

The Bear River originates in the vicinity of Emigrant Gap and Lake Spaulding in the Sierra Nevada foothills. The Bear River flows southwest out of the foothills and merges with the Feather River just north of the community of Nicolaus on the valley floor. The entire Bear River drainage area is 352,000 acres (MBK Engineers and Flood Control Study Team 2002). There are three reservoirs on the Bear River: Rollins Reservoir, Lake Combie, and Camp Far West Reservoir. Table B-3 in Appendix B shows monthly average flows for the Bear River below Camp Far West Reservoir from 1995 to 2004.

Water Quality

According to the 2006 Section 303(d) list of water quality–impaired rivers, the Upper Feather River–Upper Yuba River watershed is impaired for multiple pollutants, but none of the causes are related to agriculture. The majority of the problems are thought to come from resource extraction such as abandoned mines. Limited water quality data are available for the Upper Feather River–Upper Yuba River watershed from the *2007 Review of Monitoring Data for ILRP* (Central Valley Water Board 2007a). There were five monitoring sites in the Upper Feather River watershed and none in the Upper Yuba River watershed. One event resulted in toxicity to *Ceriodaphnia dubia* (water flea) at Spanish Creek below the confluence with Greenhorn Creek in the Upper Feather River watershed. The cause of toxicity was not determined. Multiple samples collected from Indian Creek, downstream from Indian Valley tested positive for *E. coli* bacteria (Table 3-9). This was attributed to grazing activities.

Table 3-9. Known Agricultural Contaminants and Conditions That Affect Water Quality in the Upper Feather River–Upper Yuba River Watershed

Parameter	Potential Agricultural Sources/ Contribution to Water Quality Impairment	Source
Bacteria (fecal coliform/*E. coli*)	Agriculture, grazing, or other sources	1
Unknown toxicity	Unknown source	1

Source:
[1] Central Valley Water Board 2007a.

Note: Water bodies in the Upper Feather River–Upper Yuba River watershed that are impacted from fecal coliform or *E. coli* include Spanish Creek, downstream of Indian Valley on the East Fork of the North Fork Feather River.

I.D Colusa Basin Watershed

General Description

The Colusa Basin Watershed is located northwest of Sacramento on the west side of the Sacramento River and encompasses approximately 1,655,846 acres (2,587 square miles) (Figure 3-1). The Sacramento River forms the entire eastern border of the watershed, and Lake County borders the watershed on the west (Figure 3-7). To the north, the watershed general borders the Glenn County and Tehama County line; to the south, the watershed extends near the City of Woodland. Major water bodies include Stony Creek, Cache Creek, Sulphur Creek, and Bear Creek and its tributaries.

Elevations in the Colusa Basin watershed range from 7,040 feet in the Coast Ranges in northwest Colusa County to 20 feet in southeast Colusa County. The annual precipitation in the Colusa Basin ranges between 16 and 24 inches, with most rainfall occurring during the winter and early spring seasons (SVWQC 2004).

The Colusa Basin is a large, shallow basin with predominantly deep, level, and fine-textured soils that are conducive to agriculture production. Typically, these soils drain slowly and are renowned for retaining and ponding water. Historically, water would pool in the Colusa Basin for extended periods during winter and spring rainfall events. However, drainage patterns in the Colusa Basin have been extensively altered during the past century of agricultural development. The Colusa Basin Drain, built by the Colusa Basin Drainage District between 1920 and 1940, is the main artery of the drainage system that now drains the Colusa Basin.

The Colusa Basin is home to a mix of irrigated cropland (primarily rice) and managed waterfowl habitat. The poorly drained soils in the Colusa Basin make it an ideal location for rice production, and the Colusa Basin contains some of the most productive rice farmland in the United States. The flooded rice fields of the Colusa Basin also create an abundance of waterfowl habitat along the Pacific Flyway. Therefore, the Colusa Basin is also home to multiple state and federal wildlife refuges, including the Sacramento NWR, the Delevan NWR, Colusa NWR, and the Colusa Bypass Wildlife Area.

Land Use Patterns

Approximately 60 percent of land use in the Colusa Basin watershed is classified by DWR as native vegetation (Figure 3-15). A predominant amount of this area of native vegetation includes the Coast Ranges foothills of western Glenn and Colusa Counties and the Mendocino National Forest lands. The foothills are mainly utilized for grazing cattle and sheep, as well as limited dryland farming. The mountainous topography of the Mendocino National Forest is used for livestock grazing, timber harvest, and recreation.

According to the DWR land use database, agricultural land use encompasses about 37 percent of the acreage in the Colusa Basin watershed. The main crop types include fruit and nut orchards (particularly walnuts and prunes), field crops, grain and hay, and rice. The majority of rice, grains, and row crops are grown west of the Sacramento River floodplain, where soils contain higher clay content and drain more slowly.

The Colusa Basin is relatively rural; urbanization is minimal, making up less than 1 percent of the land use in the watershed. Table 3-10 lists the DWR land use acreage for the Colusa Basin Watershed.

Table 3-10. Land Use Acreage according to DWR Land Use Data for the Colusa Basin

DWR Land Use Type	Acres	Percent Total
Agriculture		
Citrus and Subtropical	5,601	0.3
Deciduous Fruits and Nuts	77,535	4.7
Field Crops	80,851	4.9
Grain and Hay	78,068	4.7
Idle	17,509	1.1
Pasture	48,114	2.9
Rice	216,299	13.1
Semi agricultural and Incidental	6,583	0.4
Truck, Nursery, and Berry Crops	68,940	4.2
Vineyards	6,403	0.4
Subtotal	605,903	36.6
Urban		
Urban—Unclassified	2,819	0.2
Urban Landscape	523	0.0
Urban Residential	5,477	0.3
Commercial	887	0.1
Industrial	3,644	0.2
Vacant	12,440	0.8
Subtotal	25,790	1.6
Native		
Barren and Wasteland	4,651	0.3
Native Vegetation	958,908	57.9
Riparian Vegetation	38,239	2.3
Water Surface	22,405	1.4
Subtotal	1,024,203	61.9
Total	**1,655,896**	**100**

Basin Plan Status

The Sacramento and San Joaquin Rivers Basin Plan (Central Valley Water Board 2007b) describes beneficial uses for waters in the Colusa Basin Watershed. Table 3-11 lists the beneficial uses of the Colusa Basin Drain and Stony Creek.

Table 3-11. Beneficial Uses in the Colusa Basin Watershed

Beneficial Use	Colusa Basin Drain	Stony Creek (includes East Park and Black Butte Reservoirs)
Municipal & Domestic		
Irrigation	E	E
Stock Watering		E
Process		
Service Supply		
POW (Power)		
Rec-1*	E	E
Rec-2*		E
Freshwater Habitat—Warm	E	E
Freshwater Habitat—Cold	P	P
Migration—Warm	E	
Migration—Cold		E
Spawning—Warm	E	E
Spawning—Cold		E
Wildlife Habitat	E	E
Navigation		

P = Potential, E = Existing.

* Rec-1 indicates recreational activities involving body contact with water, where ingestion of the water is reasonably possible. These uses include, but are not limited to, swimming, wading, water skiing, skin and scuba diving, surfing, white water activities, fishing, and use of natural hot springs. Rec-2 indicates recreational activities involving proximity to water, but generally with no body contact with water or any likelihood of ingestion of water. These include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, and aesthetic enjoyment associated with the above activities.

Source: Central Valley Water Board 2007b.

Hydrology

The Colusa Basin Watershed is divided into several watersheds, including Stony Creek, the Colusa Basin Drain, and the lower portion of Cache Creek. The Stony Creek Watershed originates in the northwest corner of Colusa County, within the Mendocino National Forest. Stony Creek flows northward, to East Park Reservoir, then to Stony Gorge Reservoir, and finally to Black Butte Reservoir. From Black Butte Dam, Stony Creek flows east and eventually flows into the Sacramento River south of Hamilton City. The USGS website does not contain any recent flow data for Stony Creek; therefore, monthly average flows could not be calculated. According to USGS data, the minimum flow at Stony Creek between 1980 and 1990 was 0 cfs, the average flow was 571 cfs, and the maximum flow was 22,900 cfs.

The Colusa Basin Drain is a constructed drainage channel that originates just east of Willows in Glenn County and conveys runoff and agricultural return flows from over 1,000,000 acres of irrigated farmlands in the Colusa Basin. The Colusa Basin Drain flows the length of eastern Colusa County and ultimately drains to the Sacramento River at Knights Landing in Yolo County. It is the single largest source of agricultural return flows to the Sacramento River. The Colusa Basin Drain flows throughout the year, as summer flow is maintained by irrigation tailwater. During high winter flows, the Colusa Basin Drain is sometimes diverted through the Knights Landing Ridge Cut to the Yolo Bypass. The CDEC web site lists daily mean discharges in cubic feet per second for the Colusa Basin Drain near Highway 20 (CDEC 2005). Table B-4 in Appendix B contains monthly average flows for the Colusa Basin Drain from 1998 to 2004.

Cache Creek flows from Clear Lake and Indian Valley Reservoir in Lake County to the Sacramento River in Yolo County. The upper portion of the Cache Creek Watershed is discussed in detail in the Lake-Napa Watershed section of this report. In Colusa County, Bear Creek and its tributaries, including Sulphur Creek, Trout Creek, and Mill Creek, drain Bear Valley and a small part of the Blue Ridge foothills south of the Bear Valley. Bear Creek flows into Cache Creek just north of the Capay Valley. The USGS website contained flow data for Cache Creek at Yolo. Monthly average flows from 1995 to 2004 are included in Table B-4 in Appendix B.

The Colusa Basin also has numerous irrigation districts, including Glenn-Colusa Irrigation District (GCID), Provident Irrigation District (ID), Maxwell ID, and Reclamation District 108—among others. GCID operates a 65-mile-long irrigation canal that supplies irrigation water from a pumping station on the Sacramento River located near Hamilton City. The GCID irrigation canal supplies irrigation water to approximately 141,000 acres of farmlands through a complex water delivery system of over 900 miles of irrigation laterals and drains. In addition, the GCID canal delivers water to 20,000 acres of wildlife habitat within the Sacramento, Delevan, and Colusa NWRs.

Many smaller creeks in the Colusa Basin watershed originate in the foothills of the Coast Ranges and flow generally eastward across the valley floor. Once on the valley floor, these creeks are typically channeled through cropland and eventually drain into the Colusa Basin Drain. Most of these creeks are ephemeral and intermittent streams that occasionally flood in their lower reaches during winter storms. There is no flow information available from the USGS for these small creeks.

Water Quality

The 2006 Section 303(d) list of water quality-limited segments for impaired water bodies designates 49 miles of the Colusa Basin Drain waterway as being impaired by multiple agricultural-related chemicals, including azinphos-methyl, carbofuran, diazinon, Group A pesticides, malathion, methyl parathion, molinate/ordram, and unknown toxicity. Potential sources of these impairments are thought to be agriculture and irrigation tailwater return flows to the Colusa Basin Drain. The TMDL priority status for these water quality impairments ranges from low to medium. Table 3-12 identifies the known agricultural contaminants and conditions that affect water quality in the Colusa Basin Watershed. Appendix C contains the water quality objectives used to identify the water quality concerns listed in the table.

Extensive water quality data are available for the Colusa Basin Watershed from the *2007 Review of Monitoring Data for ILRP* (Central Valley Water Board 2007a) and the Rice Pesticide Program. There were multiple monitoring sites throughout the watershed, including irrigation laterals and tailwater return drains that contained contaminants in levels above water quality objectives. Water column samples that were collected found that diazinon, chlorpyrifos, azinphos-methyl, carbofuran, Group A pesticides, malathion, methylparathion, and molinate/ordram were a result of agricultural operations.

Multiple sampling events resulted in toxicity to *Pimephales promelas* (fathead minnow) and *Ceriodaphnia dubia* (water flea). The cause of toxicity was not determined. Many samples resulted in toxicity to algal species (*Selenastrum capricornutum*). Site No. 90 (unnamed drain of Walker Creek on County Road28) had multiple significant toxicity results for water toxicity species (fathead minnow, water flea, and algal species) as well as one exceedance in sediment toxicity. In addition, multiple pesticide detections that exceeded objectives were observed. Site No. 79 (Spring Creek at Walnut Avenue) had multiple toxic results for water flea and algal species, as well as one for sediment toxicity. This particular monitoring site also had multiple detections of the organosphate pesticides diazinon and chlorpyrifos that largely were found to be a result of agriculture return flows (Central Valley Water Board 2007a, Weston et al. In Press).

Table 3-12. Known Agricultural Contaminants and Conditions That Affect Water Quality in the Colusa Basin Watershed

Parameter	Potential Agricultural Source/ Contribution to Water Quality Impairment	Sources
Azinphos-methyl	Pesticide applied to agricultural crops	2
Carbofuran	Pesticide applied to agricultural crops	2
Diazinon	Pesticide applied to agricultural crops	1, 2
Group A pesticides	Pesticides applied to agricultural crops	2
Malathion	Pesticide applied to agricultural crops	2
Methyl parathion	Pesticide applied to agricultural crops	2
Molinate/ordram	Pesticide applied to agricultural crops	2
Chlorpyrifos (in water column)	Pesticide applied to agricultural crops	3
Unknown toxicity	Agriculture and irrigation tailwater return flows to the Colusa Basin Drain	1, 2
Bacteria (fecal coliform/*E. coli*)	Agriculture, grazing, or other sources	1
Bifenthrin (in sediment)	Pesticide applied to agricultural crops	3
Fenproprathin (in sediment)	Pesticide applied to agricultural crops	3
Chlorpyrifos (in sediment)	Pesticide applied to agricultural crops	3

Sources:

[1] Central Valley Water Board 2007a (including Rice Pesticide Program).

[2] 2006 Section 303(d) list.

[3] Weston et al. In Press.

Note: Water bodies that are impacted from one or more of the contaminants listed in this table include the Colusa Basin Drain, Jack Slough, portions of the Sacramento River, Stony Creek, Stone Corral Creek, Coon Creek, Spring Creek in Colusa County, an unnamed drain of Walker Creek on County Road 28, and an unnamed drain in Glenn County.

I.E Butte-Sutter-Yuba Watershed

General Description

The Butte-Sutter-Yuba Watershed is located in northern California (Figure 3-1). The Sacramento River forms the western boundary of the Butte-Sutter-Yuba Watershed, and the Upper Feather River–Upper Yuba River Watershed forms the eastern boundary (Figure 3-8). To the north is generally the Butte and Tehama County line and to the south is approximately where the Feather River meets the Sacramento River. The Butte-Sutter-Yuba Watershed is approximately 1,697,969 acres **(**2,653 square miles). Elevation ranges from 6,754 feet in the eastern foothills to 91 feet in the west along the Sacramento River (SVWQC 2004).

The five main hydrologic features in the watershed are the Feather River, Lake Oroville, the Yuba River, the Bear River, and the Sacramento River. The Feather River flows from north to south, and the Yuba River and Bear River generally flow east to west until their confluence with the Feather River on the valley floor. Annual precipitation varies with elevation and ranges from 15 inches in western Sutter County to 80 inches in northeast Yuba County. The total annual precipitation is 21.04 inches at Marysville, at an elevation of 65 feet (SVWQC 2004).

Land Use Patterns

Native vegetation covers just over half (57 percent) of the Butte-Sutter-Yuba Watershed (Figure 3-16). Table 3-13 includes the land use acreages in the watershed according to DWR and FRAP land use data.

The Butte-Sutter-Yuba Watershed is under intensive agricultural production; almost 36 percent of the land area is agriculture. Rice is the predominant crop in the watershed, constituting 15.4 percent of the land use. Deciduous fruits and nut orchards are the second most prevalent land use in the watershed, representing 9.6 percent of the land use in the watershed. Field crops account for nother 3.5 percent of the total acreage, and urban for 4.3 percent of the land use in this watershed.

Table 3-13. Land Use Acreage according to DWR and FRAP Land Use Data for the Butte-Sutter-Yuba Watershed

Land Use	Acres	Percent Total
DWR Land Use Type		
Agriculture		
Citrus and Subtropical	8,173	0.5
Deciduous Fruits and Nuts	161,944	9.6
Field Crops	59,122	3.5
Grain and Hay	26,300	1.6
Idle	16,987	1.0
Pasture	33,003	2.0
Rice	260,439	15.4
Semi agricultural and Incidental	5,870	0.4
Truck, Nursery, and Berry Crops	35,371	2.1

Land Use	Acres	Percent Total
Vineyards	589	0.0
Subtotal	607,803	35.9
Urban		
Urban—Unclassified	34,311	2.0
Urban Residential	20,589	1.2
Urban Landscape	2,001	0.1
Commercial	2,045	0.1
Industrial	6,507	0.4
Vacant	6,782	0.4
Subtotal	72,237	4.3
Native		
Native Vegetation	889,633	52.5
Barren and Wasteland	11,279	0.7
Riparian Vegetation	62,446	3.7
Water Surface	37,538	2.2
Subtotal	1,000,897	59.0
FRAP Land Use Type		
Agriculture	30	0.0
Annual Grassland	1,957	0.1
Barren	13	0.0
Blue Oak Woodland	3,152	0.2
Blue Oak-Foothill Pine	700	0.0
Douglas-Fir	20	0.0
Mixed Chaparral	217	0.0
Montane Hardwood	5,851	0.4
Montane Hardwood-Conifer	1,279	0.1
Ponderosa Pine	1,187	0.1
Urban	94	0.0
Valley Oak Woodland	65	0.0
Water	86	0.0
Subtotal	14,657	0.9
Total	**1,695,596**	**100**

Basin Plan Status

The Sacramento and San Joaquin Rivers Basin Plan (Central Valley Water Board 2007b) describes beneficial uses for waters in the Butte-Sutter-Yuba Watershed. Table 3-14 lists the beneficial uses for the Feather River (from Oroville to the Sacramento River), Sutter Bypass, Yuba River (sources to Englebright Reservoir and from Englebright Dam to Feather River), Upper Bear River, and Butte Creek (to Butte Slough).

Table 3-14. Beneficial Uses in the Butte-Sutter-Yuba Watershed

Beneficial Uses	Feather River (from Oroville to the Sacramento River)	Sutter Bypass	Yuba River to Englebright Reservoir	Yuba River—Englebright Dam to Feather River	Upper Bear River	Butte Creek to Butte Slough
Municipal & Domestic	E		E		E	
Irrigation	E	E	E	E	E	E
Stock Watering			E	E	E	E
Process						
Service Supply				E		
POW (Power)			E	E	E	E
Rec-1*	E	E	E	E	E	E
Rec-2*	E		E	E	E	
Freshwater Habitat—Warm	E			E	E	E
Freshwater Habitat—Cold	E		E	E	E	E
Migration—Warm	E			E	P	
Migration—Cold	E	E		E	P	E
Spawning—Warm	E	E		E	P	E
Spawning—Cold	E		E	E	P	E
Wildlife Habitat	E	E	E	E	E	E
Navigation						

P = Potential, E = Existing.

* Rec-1 indicates recreational activities involving body contact with water, where ingestion of the water is reasonably possible. These uses include, but are not limited to, swimming, wading, water skiing, skin and scuba diving, surfing, white water activities, fishing, and use of natural hot springs. Rec-2 indicates recreational activities involving proximity to water, but where there is generally no body contact with water, or any likelihood of ingestions of water. These include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, and aesthetic enjoyment associated with the above activities.

Source: Central Valley Water Board 2007b.

Hydrology

Lake Oroville lies in the foothills of the western slope of the Sierra Nevada. Lake Oroville has a storage capacity of more than 3.5 million acre-feet and is the largest State Water Project (SWP) facility in northern California. Lake Oroville stores runoff from the various large tributaries of the Feather River, including the North, South, and Middle Forks of the Feather River and the West Branch Feather River. The North Fork Feather River and the West Branch Feather River form the northern arm of Lake Oroville. The lower portions of the Middle Fork Feather River and South Fork Feather River form the eastern arm of Lake Oroville. The Feather River drains an area of approximately 2,304,000 acres at Lake Oroville (MBK Engineers and Flood Control Study Team 2002). The USGS monitors flow on the Feather River near Oroville (11407000), and monthly average flows are included in Table B-5 in Appendix B.

A majority of the Upper Yuba River Watershed, including New Bullards Bar Reservoir, is outside the Butte-Sutter-Yuba Watershed. The 60 river miles of the Lower Yuba River between the New Bullards Bar Reservoir release point and the confluence with the Feather River near Marysville are within the Butte-Sutter-Yuba Watershed. The USGS monitors flow on the Lower Yuba River near Marysville (11421000), and monthly average flows for the Lower Yuba River are included in Table B-5 in Appendix B.

The Bear River originates in the vicinity of Emigrant Gap and Lake Spaulding in the western Sierra Nevada foothills and flows southwest to its confluence with the Feather River on the valley floor. The entire Bear River drainage area is 352,000 acres (MBK Engineers and Flood Control Study Team 2002). All upstream reservoirs on the Bear River are outside the Butte-Sutter-Yuba Watershed and are not discussed in this analysis. The portion of the Bear River that falls within the boundaries of this watershed originates immediately downstream of Camp Far West Reservoir and flows into Feather River at Nicolaus. Average flows in the Bear River measured below Camp Far West Reservoir are shown in Table B-5 in Appendix B.

The drainage basin of Butte Slough lies east of the Sacramento River, south of Chico, and north of the Sutter Buttes. The Butte Slough drains into the Sacramento River upstream of the Feather River confluence near Colusa. During periods of normal flow, the Sutter Bypass enters the Sacramento River via the Sacramento Slough. During periods of high flow, the Sutter Bypass channel fills completely and is diverted to the Sacramento River. Average flows for Butte Creek near Chico and the Sutter Bypass are shown in Table B-5 in Appendix B.

The Feather River drains into the Sacramento River near the community of Verona. The Sacramento River at Verona includes a combination of the flow for the entire Butte-Sutter-Yuba Watershed, as well as all the upstream Sacramento River flows from east side and west side tributaries, and including flow releases from Lake Shasta. The Sacramento River flow at Verona is regulated by coldwater releases from both Shasta Dam and Oroville Dam. Average flows in the Sacramento River near Verona are shown in Table B-5 in Appendix B.

Water Quality

Multiple water bodies in the Butte-Sutter-Yuba Watershed are listed as impaired on the 2006 Section 303(d) list. Identified sources of impairments in the Butte-Sutter-Yuba Watershed are generally limited to agricultural and resource extraction (mining).

Butte Slough and the Lower Bear River (below Camp Far West Reservoir) are listed as impaired for diazinon. The Lower Feather River (from Lake Oroville to the confluence with the Sacramento River) is listed as impaired for chlorpyrifos, Group A pesticides, mercury, and unknown toxicity. Sacramento Slough is impaired for mercury from an unknown source. The Sacramento River (from Knights Landing to the Delta) is listed as impaired for mercury and unknown toxicity. These impairments are considered primarily to be attributable to agriculture and resource extraction.

According to water quality data for the Upper Feather River, the quality of water entering Lake Oroville is excellent, and Lake Oroville itself generally is excellent. The Upper North Fork of the Feather River and Lake Oroville are not listed as impaired on the 2006 Section 303(d) list for any contaminants; but the Feather River from Oroville Dam to its confluence with the Sacramento River is impaired for diazinon, Group A pesticides, mercury, and unknown toxicity.

Extensive water quality data are available for the Butte-Sutter-Yuba Watershed from the *2007 Review of Monitoring Data for ILRP* (Central Valley Water Board 2007a). The multiple monitoring sites in this watershed included Butte Slough at Lower Pass Road, Sacramento Slough Bridge, Yankee Slough, Hamilton Slough, the Bear River, and several sites on Butte Slough and the Wadsworth Canal.

The 2007 monitoring results from six monitoring events in the Butte-Sutter-Yuba Watershed demonstrated statistically significant toxicity to fathead minnow (*Pimephales promelas*). The 2007 monitoring results also showed that four monitoring events in the watershed resulted in toxicity to water flea (*Ceriodaphnia dubia*). Thirty-six monitoring events in the watershed resulted in statistically significant toxicity to algal species (*Selenastrum capricornutum*). Three monitoring events in the watershed indicated toxicity to *Hyalella azteca* (a sediment amphipod). Site No. 96 (Yankee Slough at Swanson Road) had multiple detections of chlorpyrifos, diazinon, and malathion over the trigger limits. This site also had multiple toxic results for algal species. Site No. 3, Butte Slough at Lower Pass Road, had multiple toxic results for fathead minnow, water flea, and algal species. Five tests for *E. coli* resulted in measurements above the objectives. (Central Valley Water Board 2007a.)

Table 3-15 lists the known agricultural contaminants and conditions that affect water quality in the Butte-Sutter-Yuba Watershed. Appendix C contains the water quality objectives used to identify the water quality concerns listed in the table.

Table 3-15. Known Agricultural Contaminants and Conditions That Affect Water Quality in the Butte-Sutter-Yuba Watershed

Parameter	Potential Agricultural Source/ Contribution to Water Quality Impairment	Sources
Diazinon	Pesticide applied to agricultural crops	2, 3
Chlorpyrifos	Pesticide applied to agricultural crops	2
Group A Pesticides	Pesticides used to protect agricultural crops	2
Bacteria (fecal coliform/*E. coli*)	Agriculture, grazing, or other sources	1
Toxicity	Unknown source	1, 2

Sources:
[1] Central Valley Water Board 2007a.
[2] 2006 Section 303(d) list.
[3] USGS 2005c.

Note: Water bodies that are impacted from one or more of the contaminants listed in this table include Butte Slough, (Lower) Bear River, (Lower) Feather River, Sacramento River (Knights Landing to the Delta), Sacramento Slough, and the Sutter Bypass.

I.F Lake-Napa Watershed

General Description

The Lake-Napa Watershed is located in the southern portion of the central Coast Ranges, west of the valley floor in northern California (Figure 3-1). The entire Lake-Napa Watershed is approximately 897,881 acres (1,403 square miles). Mendocino County borders the Lake-Napa Watershed immediately to the west and northwest, while Sonoma County borders the watershed to the west and southwest (Figure 3-9). Elevations range from 4,299 feet at Mount Konocti to less than 700 feet in Big Valley. The two primary drainages in the Lake-Napa Watershed are Upper Cache Creek and Upper Putah Creek, which both originate in Lake County and flow east towards the valley floor, ultimately draining into the Sacramento River in Yolo County (SVWQC 2004). Three other major hydrologic features in the Lake-Napa Watershed are Clear Lake and the Indian Valley Reservoir in Lake County and Lake Berryessa in northeast Napa County.

The Lake-Napa Watershed has a Mediterranean climate, which is characterized by warm, dry summers and moist, cool winters. Precipitation in the Clear Lake area generally occurs only as rainfall. At lake level, the average annual rainfall is 30 inches per year, and the amount increases considerably at higher elevations surrounding the lake (SVWQC 2004).

Land Use Patterns

According to DWR, almost 86 percent of the land in the Lake-Napa Watershed is classified as native vegetation (Figure 3-17). Surface water areas, including Clear Lake, Lake Berryessa, and the Indian Valley Reservoir, are the second largest land use designation in the watershed—utilizing 7 percent of the land in the watershed. Table 3-16 presents land use acreage according to DWR land use data for the Lake-Napa Watershed.

Table 3-16. Land Use Acreage according to DWR Land Use Data for the Lake-Napa County Watershed

DWR Land Use Type	Acres	Percent Total
Agriculture		
Citrus and Subtropical	5	0.0
Deciduous Fruits and Nuts	11,122	1.2
Field Crops	8	0.0
Grain and Hay	2,079	0.2
Idle	5,077	0.6
Pasture	5,905	0.7
Rice	941	0.1
Semi agricultural and Incidental	961	0.1
Truck, Nursery, and Berry Crops	199	0.0
Vineyards	12,320	1.4
Subtotal	38,617	4.3

DWR Land Use Type	Acres	Percent Total
Urban		
Urban—Unclassified	367	0.0
Urban Residential	16,874	1.9
Urban Landscape	352	0.0
Commercial	1,466	0.2
Industrial	1,743	0.2
Vacant	667	0.1
Subtotal	21,469	2.4
Native		
Native Vegetation	770,172	85.9
Barren and Wasteland	1,012	0.1
Riparian Vegetation	1,400	0.2
Water Surface	65,212	7.3
Subtotal	837,796	93.4
Total	**896,865**	**100**

Basin Plan Status

The Sacramento and San Joaquin Rivers Basin Plan (Central Valley Water Board 2007b) describes beneficial uses for waters in the Lake-Napa Watershed. Table 3-17 lists the beneficial uses of Cache Creek (Clear Lake to the Yolo Bypass) and Putah Creek (Lake Berryessa to the Yolo Bypass).

Hydrology

The two primary drainages in the Lake-Napa Watershed are Upper Cache Creek and Upper Putah Creek, which originate in Lake County and flow east toward the valley floor, ultimately draining into the Sacramento River in Yolo County (SVWQC 2004).

The Upper Cache Creek watershed is divided into two drainages, the North Fork and the Main Fork. The North Fork Cache Creek originates in the mountains northwest of Indian Valley Reservoir in Lake County, and drains into the reservoir. The Main Fork Cache Creek originates below the Indian Valley Reservoir.

Clear Lake is the largest natural freshwater lake located entirely within California (SVWQC 2004). Clear Lake is characterized as a eutrophic lake. Lake depths range from 20 to 50 feet, and storage capacity is estimated to be approximately 313,000 acre-feet. Clear Lake discharges into the Main Fork Cache Creek through the Clear Lake Dam. Monthly average flows from 1995 to 2004 for the Main Fork Cache Creek measured near Lower Lake are included in Table B-6 in Appendix B. Some minor tributaries that join the lower portion of Lower Cache Creek in the Lake-Napa Watershed are Bear Creek and Harley Gulch.

The second hydrologic unit in the Lake-Napa County Watershed is Upper Putah Creek. Lake Berryessa is the major hydrologic feature of the Napa County portion of the Lake–Napa Watershed and has a storage capacity of 1, 602,000 acre-feet. Upper Putah Creek originates in the mountains above Lake Berryessa and drains into Lake Berryessa on the northwest shore of the lake. Monthly average flows from 1998 to 2004 for Upper Putah Creek measured near Guenoc are included in Table B-6 in Appendix B. Lower Putah Creek originates below Lake Berryessa and is primarily located in the Yolo-Solano County Watershed.

Table 3-17. Beneficial Uses in the Lake-Napa Watershed

	Cache Creek		Putah Creek	
Beneficial Uses	Clear Lake[(a)]	Clear Lake to Yolo Bypass [(b)]	Lake Berryessa	Lake Berryessa to Yolo Bypass
Municipal & Domestic	E	E	E	E
Irrigation	E	E	E	E
Stock Watering	E	E	E	E
Process		E		
Service Supply		E		
POW (Power)			P	
Rec-1*	E	E	E	E
Rec-2*	E	E	E	E
Freshwater Habitat—Warm	E	E	E	E
Freshwater Habitat—Cold	P	P	E	P
Migration—Warm				
Migration—Cold				
Spawning—Warm	E	E	E	E
Spawning—Cold		E		
Wildlife Habitat	E	E	E	E
Navigation				

P = Potential, E = Existing.

(a) The following beneficial uses *Exist* in addition to those noted: Mud Slough (north): COMM and SHELL; Salt Slough: COMM, BIOL, and SHELL; Wetland Water Supply Channels: BIOL; Clear Lake: COMM.

(b) In addition to the beneficial uses noted in Table II-1, COMM exists for Cache Creek from Clear Lake to Yolo Bypass and in North Fork Cache Creek and Bear Creek only.

* Rec-1 indicates recreational activities involving body contact with water, where ingestion of the water is reasonably possible. These uses include, but are not limited to, swimming, wading, water skiing, skin and scuba diving, surfing, white water activities, fishing, and use of natural hot springs. Rec-2 indicates recreational activities involving proximity to water, but generally with no body contact with water or any likelihood of ingestion of water. These include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, and aesthetic enjoyment associated with the above activities.

Source: Central Valley Water Board 2007b.

Water Quality

The 2006 Section 303(d) list of water quality-impaired rivers designates multiple reaches of several rivers in the Lake-Napa Watershed as impaired. Identified sources of impairment in the Lake-Napa Watershed are primarily resource extraction (mining).

The mercury TMDL for Clear Lake was approved by the Water Board in 2002 and subsequently approved by EPA in 2003. The mercury TMDL for Clear Lake is currently in the implementation phase. The mercury TMDL for Clear Lake identifies resource extraction to be the primary source, with unknown sources from the tributaries.

In addition, Clear Lake is listed as impaired for nutrients from an unknown source. Currently, Central Valley Water Board staff is working on a nutrient TMDL for Clear Lake. Nutrient reduction responsibilities have been identified in the draft TMDL report.

Ninety-six miles of Lower Cache Creek (from Clear Lake Dam to the Cache Creek Settling Basin near the Yolo Bypass) are impaired for unknown toxicity from an unknown source. Lake Berryessa is listed as impaired for mercury. The *Cache Creek, Bear Creek and Harley Gulch Mercury TMDL* was approved by the Water Board in 2005 and subsequently was approved by EPA.

Pesticide use in the Lake-Napa County Watershed primarily consists of pesticides applied to lands in the Napa County portion of the Upper Putah Creek drainage, and the majority of the pesticides are applied to wine grapes. However, no water bodies in the Lake-Napa County Watershed are listed as impaired for any pesticides.

Limited water quality data are available for the Lake-Napa County Watershed from the *2007 Review of Monitoring Data for ILRP* (Central Valley Water Board 2007a). Two water quality monitoring sites were located in tributaries to Clear Lake, and two water quality monitoring sites were located in tributaries to Lake Berryessa. One sampling event resulted in toxicity to C*eriodaphnia dubia* (water flea) at McGaugh Slough, at Finley Road East near Clear Lake. In addition, one sample collected from Capell Creek, upstream from Lake Berryessa, tested positive for *E. coli* bacteria. One of five samples collected from Pope Creek, upstream of Lake Berryessa, also tested positive for *E. coli* bacteria. Three of four water quality samples collected at McGaugh Slough at Finley Road East tested positive for *E. coli* bacteria. Table 3-18 lists the known agricultural contaminants and conditions that affect water quality in the Lake-Napa Watershed. Appendix C contains the water quality objectives used to identify the water quality concerns listed in the table.

Table 3-18. Known Agricultural Contaminants and Conditions That Affect Water Quality in the Lake-Napa Watershed

Parameter	Potential Agricultural Source/ Contribution to Water Quality Impairment	Sources
Nutrients	Source unknown	1, 2
Bacteria (fecal coliform/*E. coli)*	Agriculture, grazing, or other sources	2
Toxicity	Source unknown	1

Sources:

[1] 2006 Section 303(d) list.

[2] Central Valley Water Board 2007a.

Note: Water bodies that are impacted from one or more of the contaminants listed in this table include Clear Lake, Lower Cache Creek, tributaries to Clear Lake, and Lake Berryessa.

I.G Solano-Yolo Watershed

General Description

The Solano-Yolo Watershed lies west of the Sacramento metropolitan area in northern California (Figure 3-1). It encompasses the Capay Valley to the northwest, and follows the Sacramento River to the Delta near Suisun Bay. The Solano-Yolo Watershed borders Sutter, Placer, Sacramento and San Joaquin counties to the east; and Napa and Lake Counties to the west (Figure 3-10). The Solano-Yolo Watershed is approximately 899,539 acres (1,406 square miles). The western portion of the watershed consists of the hilly to steep mountainous terrain of the Coast Ranges, with a maximum elevation of 2,819 feet. The remainder of the watershed lies on the floor of the Central Valley.

Average annual precipitation ranges from 16 inches in some of the southern parts of the watershed, to as much as 30 inches at the top of the Coast Ranges (SVWQC 2004). The major water features in the watershed include Lower Putah Creek, Lower Cache Creek, the Lower Sacramento River, the Yolo Bypass, the Sacramento River Deep Water Ship Channel, and the confluence of the Sacramento River and the Delta.

Land Use Patterns

Table 3-19 depicts the land use acreage according to DWR land use data for the Solano-Yolo Watershed. Agriculture constitutes a large portion of the Solano-Yolo Watershed, and approximately 58 percent of the land use in the watershed is in agricultural production. The largest single irrigated agricultural commodity in the Yolo-Solano Watershed is field crops.

The second largest portion of the land use in the Solano-Yolo watershed consists of native vegetation, which comprises 31 percent of the total acreage in the watershed (Figure 3-18). A majority of the native vegetation is located in the Coast Ranges foothills on the west side of the watershed, as well as the Montezuma Hills and Hill Slough Wildlife Area southeast of Vacaville.

Table 3-19. Land Use Acreage according to DWR Land Use Data for the Solano-Yolo Watershed

Land Use	Acres	Percent Total
Agriculture		
Citrus and Subtropical	291	0.0
Deciduous Fruits and Nuts	37,818	4.2
Field Crops	159,486	17.7
Grain and Hay	122,221	13.6
Idle	14,207	1.6
Pasture	86,503	9.6
Rice	14,414	1.6
Semi agricultural and Incidental	5,668	0.6
Truck, Nursery, and Berry Crops	67,979	7.6
Vineyards	14,091	1.6

Land Use	Acres	Percent Total
Entry Denied	2,697	0.3
Subtotal	525,375	58.4
Urban		
Urban—Unclassified	27,183	3.0
Urban Residential	4,942	0.6
Urban Landscape	1,891	0.2
Commercial	1,772	0.2
Industrial	7,004	0.8
Vacant	7,880	0.9
Subtotal	50,672	5.6
Native		
Native Classes Unsegregated	578	0.1
Native Vegetation	282,739	31.4
Barren and Wasteland	1,325	0.2
Riparian Vegetation	13,773	1.5
Water Surface	25,076	2.8
Subtotal	323,491	36.0
Total	**899,539**	**100**

Basin Plan Status

The Sacramento and San Joaquin Rivers Basin Plan (Central Valley Water Board 2007b) describes beneficial uses for waters in the Solano-Yolo Watershed. Table 3-20 lists the beneficial uses of the Yolo Bypass, Cache Creek (Clear Lake to the Yolo Bypass) and Lower Putah Creek (Lake Berryessa to the Yolo Bypass).

Table 3-20. Beneficial Uses in the Solano-Yolo Watershed

Beneficial Uses	Yolo Bypass	Cache Creek (Clear Lake to Yolo Bypass)	Lower Putah Creek (Lake Berryessa to Yolo Bypass)
Municipal & Domestic		E	E
Irrigation	E	E	E
Stock Watering	E	E	E
Process		E	
Service Supply		E	
POW (Power)			
Rec-1*	E	E	E
Rec-2*	E	E	E
Freshwater Habitat—Warm	E	E	E
Freshwater Habitat—Cold	E	P	P
Migration—Warm	E		

Beneficial Uses	Yolo Bypass	Cache Creek (Clear Lake to Yolo Bypass)	Lower Putah Creek (Lake Berryessa to Yolo Bypass)
Migration—Cold	E		
Spawning—Warm	E	E	E
Spawning—Cold		E	
Wildlife Habitat	E	E	E
Navigation			

P = Potential, E = Existing.

* Rec-1 indicates recreational activities involving body contact with water, where ingestion of the water is reasonably possible. These uses include, but are not limited to, swimming, wading, water skiing, skin and scuba diving, surfing, white water activities, fishing, and use of natural hot springs. Rec-2 indicates recreational activities involving proximity to water, but generally with no body contact with water or any likelihood of ingestion of water. These include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, and aesthetic enjoyment associated with the above activities.

Source: Central Valley Water Board 2007b.

Hydrology

The major water features in the watershed include Lower Putah Creek, Lower Cache Creek, the Lower Sacramento River, the Yolo Bypass, the Sacramento River Deep Water Ship Channel, and the confluence of the Sacramento River and the Delta.

Upper Cache Creek is one of the many tributaries that flow into Clear Lake; Lower Cache Creek drains out of the bottom of Clear Lake and flows into the Yolo Bypass near West Sacramento. Upper Putah Creek feeds Lake Berryessa; Lower Putah Creek drains out of the bottom of Lake Berryessa and flows into the Yolo Bypass. Upper Putah Creek and Lake Berryessa are located in the Lake-Napa Watershed, and are discussed in detail in that section. Lower Putah Creek defines a majority of the boundary between Yolo and Solano Counties, except for its confluence with the Sacramento River. The CDEC website contains flow data for Lower Putah Creek near Winters. Monthly minimum, mean, and maximum flows on Lower Putah Creek from 1995 to 2004 are included in Table B-7 in Appendix B.

The Sacramento River forms the northeastern boundary of the Solano-Yolo Watershed from the confluence of the Feather River, until south of the Sacramento metropolitan area. Monthly average minimum, mean, and maximum flows from 1995 to 2004 for the Sacramento River at Freeport are included in Table B-7 in Appendix B.

The Sacramento Deep Water Ship Channel was built by the Corps in 1963 to provide easy access for ships to the Sacramento metropolitan area. The channel splits from the Sacramento River just north of the city of Rio Vista and travels north along the west side of the Sacramento River until it ends in the City of West Sacramento. The channel is about 30 feet deep, 200 feet wide, and 43 miles long. No known flow monitoring stations are located on the Sacramento River Deep Water Ship Channel.

The Yolo Bypass is a 59,000-acre floodway bypass that protects Sacramento and other Central Valley communities from flooding. The bypass originates near Knights Landing on the west side of the Sacramento River and ends a few miles north of the community of Rio Vista near the Delta. At this location, the Yolo Bypass joins Prospect Slough and Cache Creek Slough at the outlet of the Sacramento

Deep Water Ship Channel. Weirs connect the Yolo Bypass to the Sacramento River, as well as to Cache Creek. During wet years, the Yolo Bypass can be completely full of floodwaters. The Yolo Bypass contains the Vic Fazio Yolo Wildlife Area and forms a large wetland area during many months of the year. In summer, the Yolo Bypass is used for agriculture, primarily rice production.

Water Quality

The Lower Sacramento River and Lower Putah Creek are listed as impaired in the 2006 Section 303(d) list. Identified sources of impairment in the Solano-Yolo Watershed are agricultural and resource extraction (mining).

The Lower Sacramento River (from Knights Landing to the Delta) is impaired for mercury, unknown toxicity, and diazinon.

Lower Putah Creek is impaired for mercury along 28 miles of its lower reach, between Lake Solano and the Putah Creek Sinks (Central Valley Water Board 2007b). Ninety-six miles of Lower Cache Creek, from Clear Lake Dam to the Cache Creek Settling Basin near the Yolo Bypass, are listed as impaired for unknown toxicity from an unknown source. The *Cache Creek, Bear Creek and Harley Gulch Mercury TMDL* was approved by the Water Board in 2005, and subsequently approved by EPA.

Extensive water quality data are available for the Solano-Yolo County Watershed from the *2007 Review of Monitoring Data for ILRP* (Central Valley Water Board 2007a). The multiple monitoring sites throughout the watershed included irrigation laterals and tailwater return drains. Five sampling events resulted in toxicity to *Ceriodaphnia dubia* (water flea).

Six water quality monitoring samples resulted in statistically significant toxicity to algal species (*Selenastrum capricornutum*). Four sediment monitoring samples resulted in statistically significant toxicity to a sediment amphipod (*Hyalella azteca*).

In addition, 19 samples collected from various locations around the Solano-Yolo watershed tested positive for *E. coli* bacteria. Table 3-21 lists the known agricultural contaminants and conditions that affect water quality in the Solano-Yolo Watershed. Appendix C contains the water quality objectives used to identify the water quality concerns listed in the table.

Table 3-21. Known Agricultural Contaminants and Conditions That Affect Water Quality in the Solano-Yolo Watershed

Parameter	Potential Agricultural Source/ Contribution to Water Quality Impairment	Sources
Diazinon	Pesticide used to protect agricultural crops	1, 2
Bacteria (fecal coliform/*E. coli)*	Agricultural, grazing, or other sources	2
Toxicity	Unknown source	1, 2

Sources:

[1] 2006 Section 303(d) list.

[2] Central Valley Water Board 2007a.

Note: Water bodies that are impacted from one or more of the contaminants listed in this table include Lower Sacramento River; Lower Putah Creek; and various irrigation canals, laterals, and drains throughout the Solano-Yolo Watershed.

I.H American River Watershed

General Description

The headwaters of the American River watershed originate east of Sacramento in the Sierra Nevada foothills. The American River watershed borders the Tahoe Basin on the east and extends west toward Sacramento (Figure 3-1). The Bear River generally follows the northern boundary of the watershed. The southern border of the watershed generally corresponds to the path of the Cosumnes River. The American River watershed encompasses approximately 1,805,605 acres (approximately 2,000 square miles) (Figure 3-11). Elevations in the American River watershed range from 10,400 feet in the high peaks of the Sierra Nevada to only 30 feet near Sacramento. The watershed is divided into three primary branches: the North and Middle Forks of the American River, which merge near the town of Auburn, and the South Fork of the American River, which flows directly into Folsom Lake.

In the upper elevations of the watershed, the annual average precipitation ranges from 65 to 75 inches. In the middle elevations of the watershed, the amount of annual average precipitation ranges between 35 and 45 inches. At the watershed's lowest elevations, near Folsom Reservoir, precipitation ranges from 22.5 to 27.5 inches per year.

Land Use Patterns

Over 40 percent of the American River watershed is undeveloped and categorized as native vegetation by DWR (Figure 3-19). These undeveloped areas are primarily located in the eastern foothills of the watershed. The western portion of the American River watershed is highly urbanized. Mixed agricultural land uses include rice farming, irrigated and non-irrigated pastureland, fruit tree crops, and livestock (SVWQC 2004).

Table 3-22 contains DWR and FRAP land use data by land use type. Urban land use consists of about 13 percent of the watershed area. Irrigated agriculture comprises approximately 10 percent of the American River watershed, and the largest irrigated agricultural commodity is rice.

Table 3-22. Land Use Acreage according to DWR and FRAP Land Use Data for the American River Watershed

Land Use	Acres	Percent Total
DWR Land Use Type		
Agriculture		
Citrus and Subtropical	412	0.0
Deciduous Fruits and Nuts	6,684	0.4
Field Crops	20,014	1.1
Grain and Hay	18,097	1.0
Idle	13,736	0.8
Pasture	34,536	1.9
Rice	73,289	4.1
Semi agricultural and Incidental	3,092	0.2

Land Use	Acres	Percent Total
Truck, Nursery, and Berry Crops	2,935	0.2
Vineyards	961	0.1
Subtotal	173,757	9.6
Urban		
Urban—Unclassified	145,510	8.1
Urban Landscape	7,115	0.4
Urban Residential	21,500	1.2
Commercial	2,173	0.1
Industrial	10,351	0.6
Vacant	22,790	1.3
Subtotal	209,438	11.6
Native		
Native Vegetation	720,694	39.9
Barren and Wasteland	8,363	0.5
Riparian Vegetation	6,469	0.4
Water Surface	15,831	0.9
Subtotal	751,356	41.6
FRAP Land Use Type		
Agriculture	6,180	0.3
Barren	27,148	1.5
Conifer	397,516	22.0
Hardwood	106,395	5.9
Herbaceous	33,484	1.9
Shrub	59,930	3.3
Water Surface	15,609	0.9
Wetland	4,992	0.3
Urban	19,805	1.1
Subtotal	671,058	37.2
Total	**1,805,609**	**100**

Basin Plan Status

The Sacramento and San Joaquin Rivers Basin Plan (Central Valley Water Board 2007b) describes beneficial uses for waters in the American River Watershed. Table 3-23 lists the beneficial uses of the American River: from the South Fork Source to Placerville, South Fork Placerville to Folsom Lake, Folsom Lake, and Folsom Dam to the Sacramento River.

Table 3-23. Beneficial Uses in the American River Watershed

	Municipal & Domestic	Irrigation	Stock Watering	Process (Industrial)	Service Supply	POW (Power)	Rec-1*	Rec-2*	Freshwater Habitat—Warm	Freshwater Habitat—Cold	Migration—Warm	Migration—Cold	Spawning—Warm	Spawning—Cold	Wildlife Habitat	Navigation
North Fork American River, Source to Folsom Lake	E	E					E	E	P	E				E	E	
Middle Fork American River, Source to Folsom Lake	E	E	E			E	E	E	P	E				E	E	
Desolation Valley Lakes							E	E		E				E	E	
South Fork American River, Source to Placerville	E					E	E	E	P	E				E	E	
South Fork American River, Placerville to Folsom Lake	E	E				E	E	E	E	E					E	
Folsom Lake	E	E			P	E	E	E	E	E			E		E	
South Fork American River, Folsom Dam to Sacramento River	E	E			E	E	E	E	E	E	E	E	E	E	E	

P = Potential, E = Existing.

* Rec-1 indicates recreational activities involving body contact with water, where ingestion of the water is reasonably possible. These uses include, but are not limited to, swimming, wading, water skiing, skin and scuba diving, surfing, white water activities, fishing, and use of natural hot springs. Rec-2 indicates recreational activities involving proximity to water, but generally with no body contact with water or any likelihood of ingestion of water. These include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, and aesthetic enjoyment associated with the above activities.

Source: Central Valley Water Board 2007b.

Hydrology

The American River Watershed consists of the North, Middle, and the South Forks of the American River, and Folsom Lake and several smaller creeks that are described later in this section. Folsom Dam is operated by Reclamation and regulates runoff from all three forks of the American River. Folsom Dam has a storage capacity of 975,000 acre-feet (Geotechnical Consultants 2003). Folsom Lake provides both flood protection and recreational opportunities for the Sacramento metropolitan area. Flows in the Lower American River also are regulated by Nimbus Dam, a small regulating structure located downstream of Folsom Dam. A series of levees along the Lower American River also provides flood protection to the Sacramento metropolitan area.

The Federal Wild and Scenic Rivers Act, adopted by Congress in 1968, preserves selected rivers in a free-flowing condition when they possess one or more outstanding designated values. The state of California also has a Wild and Scenic River system with an accompanying list of specially designated rivers. The lower American River is federally and state designated as “Recreational” from Nimbus Dam to the confluence of the Sacramento River. Under the California Wild and Scenic River System, portions of the North Fork American River are designated as “Wild” and “Scenic” in the vicinity of Forest Hill-Soda Springs Road.

American River

The South Fork American River flows east to west from the headwaters in the Sierra Nevada to Folsom Reservoir. At 537,166 acres in area (approximately 840 square miles), the South Fork American River watershed includes 81 topographically delineated sub-basins (SVWQC 2004). Flow data for the South Fork American River at Chili Bar are included in Table B-8 of Appendix B. Flow generally ranges from approximately 130 cfs during dry months to approximately 3,600 cfs during winter.

About 40 percent of the entire length of the South Fork American River above Folsom Reservoir is at an elevation greater than 5,000 feet (El Dorado County 2001). At the higher elevations, precipitation is often in the form of snow, with the maximum accumulation typically occurring by April 1 (SVWQC 2004). Portions of the watershed located above 6,000 feet in elevation maintain a snowpack until warmer weather causes snowmelt (usually March–June).

The lower basin of the American River is distinctly different from the upper basin. Below the town of Folsom, the American River emerges onto an alluvial plain with high, steep bluffs on the north side. Downstream, below Rancho Cordova, there is very little topography, and the American River meanders toward the confluence of the Sacramento River. Flows for the American River at Fair Oaks are included in Table B-8 of Appendix B. Flow generally ranges from approximately 1,000 cfs during dry months to up to 31,000 cfs during winter.

Other Creeks

Multiple drainages are located in the agricultural areas north of Sacramento, including Auburn Ravine, Markham Ravine Creek, Coon Creek, Pleasant Grove Creek, and Curry Creek. Auburn Ravine Creek and Coon Creek originate in the foothills near the town of Auburn, and flow west toward the Sacramento River through farmlands. All of these drainages flow into the Eastside Canal, a 4.5-mile-long floodwater conveyance, and then to the 5-mile-long Cross Canal, which empties into the Sacramento River near the town of Verona. Both the East Side Canal and the Cross Canal are flood control canals that were constructed specifically to channel flood waters around foothill communities to the Sacramento River.

Arcade Creek is one of the larger creeks in the urbanized area of Sacramento. Arcade Creek meanders through the urbanized areas of western Sacramento County and eventually drains to the Natomas East Main Drainage Canal. Approximately 80 percent of Arcade Creek’s 25,600-acre (40-square-mile) watershed is urbanized. Historically intermittent, the creek now flows year-round due to modified runoff patterns from urbanization. In addition, Arcade Creek now periodically swells to flood stage during winter storms. The USGS maintains flow monitoring stations for Arcade Creek; monthly average flows for Arcade Creek at Del Paso can be found in Table B-8 in Appendix B.

Chicken Ranch Slough and Strong Ranch Slough are two small creeks that flow through highly urbanized areas of Sacramento and eventually drain to the American River. Chicken Ranch Slough drains an area of approximately 6 square miles. Strong Ranch Slough drains an area of approximately 7 square miles. Both creeks merge and eventually drain to the lower American River prior to the American River confluence with the Sacramento River.

The Natomas East Main Drainage Canal drainage area, also known as Steelhead Creek, comprises approximately 180 square miles of land in the Sacramento metropolitan area. Just over half of the area in the Natomas East Main Drainage Canal is located in the Dry Creek Watershed. The Natomas East Main Drainage Canal is significant because it drains runoff from a large, rapidly urbanizing metropolitan area—including Dry Creek, Arcade Creek, Robla Creek, and Magpie Creek, as well as a large portion of the Natomas area. Flows for Arcade Creek are included in Table B-8 of Appendix B. Flows range from less than 1 cfs during dry months to approximately 230 cfs during winter. Flow data are not available for these other waterways.

Morrison Creek is an urbanized creek located in the southwest Sacramento area that also contains primarily urban runoff. The Morrison Creek Watershed covers approximately 150 square miles and drains to the Sacramento River. Elder Creek, Laguna Creek, and Elk Grove Creek are tributaries to Morrison Creek. Land use in the Morrison Creek Watershed is a mix of rural and urban uses, including grazing, agricultural, low- to high-density residential, industrial, and commercial. The USGS maintains flow monitoring stations for Morrison Creek. Monthly average flows for Morrison Creek can be found in Table B-8 in Appendix B.

Water Quality

Water quality conditions in the lower American River watershed are to a large degree affected by a combination of urban and industrial land uses, as well as some agricultural land uses. In contrast, the upper watershed is primarily undeveloped and water quality is affected more by the impacts of historical and current resource uses, as well as some agriculture.

A history of gold mining, and the historical legacy of mercury used to extract gold-bearing ore are assumed to be the cause of elevated levels of mercury in the American River watershed. The South Fork of the American River is listed on the 2006 Section 303(d) list for mercury from an unknown source in the reach of the river just below Slab Creek Reservoir to Folsom Lake. The reach of the Lower American River from Nimbus Dam to the confluence of the Sacramento River also is listed for mercury (State Water Board 2006). This same reach of the lower American River is listed for unknown toxicity from an unknown source (State Water Board 2006).

Unlike the upper American River Watershed, which is primarily undeveloped, the lower American River Watershed is dominated by the urbanized Sacramento metropolitan area and surrounded by agricultural land uses. These types of land uses generate both point-source and nonpoint-source discharges that contribute pollutants to surface waters.

The Natomas East Main Drain Canal drains approximately 180 square miles of the Sacramento metropolitan area. The portion of the Natomas East Main Drain Canal situated downstream of the confluence of Arcade Creek is listed as a high priority on the 2006 Section 303(d) list for diazinon, primarily from aerial deposition from agriculture and secondly from urban runoff and storm sewers. This same reach is listed as impaired for PCBs, caused by industrial point sources, agriculture, urban runoff and storm sewers. The portion of the Natomas East Main Drain Canal upstream of the confluence of Arcade Creek also is listed as impaired on the 2006 Section 303(d) list for PCBs— from the same types of agricultural, industrial, and urban sources. Table 3-24 lists the known agricultural contaminants and conditions that affect water quality in the American River Watershed. Appendix C contains the water quality objectives used to identify the water quality concerns listed in the table.

Table 3-24. Known Agricultural Contaminants and Conditions That Affect Water Quality in the American River Watershed

Parameter	Potential Agricultural Source/ Contribution to Water Quality Impairment	Sources
Chlorpyrifos	Agricultural aerial deposition, urban runoff, storm sewers	1, 2
Diazinon	Pesticide use	1, 2
PCBs	Industrial point sources, agriculture, urban runoff, storm sewers	1
Toxicity	Unknown source	1

Sources:

[1] 2006 Section 303(d) list.

[2] USGS 2005c.

Note: Water bodies that are impacted from one or more of the contaminants listed in this table include Arcade Creek, Morrison Creek, and the Natomas East Main Drain.

II SAN JOAQUIN RIVER BASIN

Introduction

The **San Joaquin River Basin** drains a region that extends across the Central Valley to the Coast Ranges, between the Cosumnes River to the north and the San Joaquin River to the South (Figure 3-2). For the purposes of this analysis, the San Joaquin River Basin includes 12 watersheds: the (A) Cosumnes River, (B) Delta-Mendota Canal, (C) San Joaquin River, (D) San Joaquin Valley Floor, (E) Delta-Carbona, (F) Ahwahnee, (G) Mariposa, (H) Upper Mokelumne River–Upper Calaveras River, (I) Merced River, (J) North Valley Floor, (K) Stanislaus River, and (L) Tuolumne River Watersheds.

The San Joaquin River Basin encompasses approximately 9.8 million acres. In general, the basin is dominated by native vegetation. The primary tributaries in the basin are the Stanislaus River, Tuolumne River, and Merced River, which meet with the San Joaquin River in the Valley floor at the basin's southern end. The basin is dominated by agriculture at the confluence of the San Joaquin and these various rivers. The San Joaquin River Basin includes most of the Delta as well as the Delta-Mendota Canal, a highly manipulated component of the Central Valley Project. Multiple canals in the Delta Mendota Canal Watershed deliver water to agricultural operations and then back to the natural drainages. Many tributaries in the watershed that would otherwise be dry during the summer irrigation season flow year-round due to agricultural return flows.

Approximately 2 million acres within the basin are classified as agricultural. Agricultural land uses in the basin are concentrated in the Valley floor—specifically in the Delta-Mendota Canal, San Joaquin Valley Floor, Delta-Carbona, and North Valley Floor Watersheds. There is very little agriculture in the remaining watersheds, less than 1 percent in most cases. The primary crops that are produced in the San Joaquin River Basin include field crops, pasture, deciduous fruits and nut orchards, vineyards, and grain and hay.

Overview of Agricultural Impacts on Surface Water in the San Joaquin River Basin

In general, agricultural operations have a greater impact on surface water in the Central Valley area around the San Joaquin River than in the higher surrounding elevations of the Coast Range and Sierra Nevada Mountains. This is primarily due to the rich fertile valley topography allowing for much larger agricultural operations.

The water quality of the San Joaquin River is of critical interest because it flows to the Delta, which is a primary source of drinking water, and supplies irrigation water to farms in the western San Joaquin Valley. One of the primary water quality concerns in the San Joaquin River Basin is the transport of pesticides by agricultural return flows to water bodies and transport of pesticides that are applied to orchards during the dormant growing season (November to January) and are transported to water bodies during rainfall events.

Water quality concerns in the San Joaquin River Basin are concentrated in the watersheds that are heavily agricultural—specifically, the Delta-Mendota Canal, San Joaquin Valley Floor, Delta-Carbona, and North Valley Floor Watersheds. Agricultural land constitutes one-third to one-half of the total land use in each of these watersheds. Correspondingly, all of these watersheds include water bodies impaired by Section 303(d)-listed pollutants that are associated with irrigated agriculture.

Water quality in the Delta-Mendota Canal, San Joaquin Valley Floor, Delta-Carbona, and North Valley Floor Watersheds is affected similarly by irrigated agriculture. Many of the rivers, creeks, and agricultural drainages in these watersheds contain low DO (generally associated with agricultural return flows), fluctuating pH, and elevated levels of EC (indicative of high salinity). Within each watershed, data indicate that chlorpyrifos, diazinon, permethrin, dieldrin, and DDT (and its breakdown products DDD and DDE) are frequently present in concentrations that exceed water quality objectives. Other pesticides are detected in these watersheds but not consistently in each watershed. These constituents include azinphos-methyl, carbofuran, cyhalthrin, cypermethrin, demeton, dieldrin, dimethoate, disulfoton, diuron, endrin, esfenvalerate/fenvalerate, linuron, malathion, methyl, methyl parathion, methomyl, simazine, thiobencarb, parathion, permethrin-1, permethrin-2, and total permethrin. In addition, elevated levels of naturally occurring metals that are mobilized and suspended in agricultural return flows are common in these watersheds—such as copper, arsenic, cadmium, boron, nickel, lead, and selenium.

A detailed analysis of the impacts on surface water in the San Joaquin River Basin is broken up by watersheds and described below.

II.A Cosumnes River Watershed

General Description

The Cosumnes River Watershed is located in central California (Sacramento and Amador Counties) (Figure 3-2). The watershed borders are San Joaquin and Calaveras Counties on the south and northern Sacramento and El Dorado Counties on the north. Sacramento County and Amador County land borders the rest of the watershed. The watershed is approximately 492,358 acres (769 square miles) and extends from the confluence of the Cosumnes and Mokelumne Rivers to the foothills of the Sierra Nevada. At its southernmost end, the watershed empties into the Mokelumne River. The two main tributaries to the Cosumnes River are Deer Creek and Laguna Creek. Elevation ranges from 80 to 4,462 feet (SVWQC 2004). (Figure 3-20.)

The watershed has a Mediterranean-type climate, characterized by dry summers and cool, moist winters. Sacramento County has an average annual precipitation that ranges from 15 to 24 inches. Rainfall totals increase as elevation increases in the eastern and northeastern parts of Sacramento County. The annual rainfall at the confluence of the Mokelumne and Cosumnes Rivers, the southwestern portion of the watershed, averages from 15 to 17 inches; Folsom, in the northeast, averages 24 inches. Approximately 80 percent of annual rainfall occurs between November and March (SVWQC 2004).

Land Use Patterns

The majority of land use in the Cosumnes River Watershed is classified as native vegetation (Figure 3-32). The surrounding area is relatively rural, and urbanization is minimal in the watershed. Table 3-25 shows the land use acreage in the watershed according to DWR and FRAP land use data. Irrigated agriculture makes up approximately 10 percent of land use.

Table 3-25. Land Use Acreage according to DWR and FRAP Land Use Data for the Cosumnes River Watershed

Land Use	Acreages	Percent Total
DWR Land Use Types		
Agriculture		
Citrus and Subtropical	209	0.0
Deciduous Fruits and Nuts	2,388	0.3
Field Crops	16,658	2.0
Grain and Hay	4,288	0.5
Idle	2,327	0.3
Pasture	22,565	2.8
Rice	186	0.0
Semi agricultural and Incidental	2,511	0.3
Truck, Nursery, and Berry Crops	2,250	0.3
Vineyards	24,051	2.9
Subtotal	77,432	9.5

Land Use	Acreages	Percent Total
Urban		
Urban—Unclassified	5,471	0.7
Urban Landscape	762	0.1
Urban Residential	15,888	1.9
Commercial	738	0.1
Industrial	4,433	0.5
Vacant	2,564	0.3
Subtotal	29,856	3.7
Native		
Native Vegetation	366,454	44.8
Barren and Wasteland	1,444	0.2
Riparian Vegetation	5,558	0.7
Water Surface	3,701	0.5
Subtotal	377,158	46.1
FRAP Land Use Types		
Agriculture	2,298	0.3
Barren and Wasteland	503	0.1
Conifer	165,820	20.3
Hardwood	91,608	11.2
Herbaceous	39,809	4.9
Shrub	19,488	2.4
Urban	11,943	1.5
Water	1,043	0.1
Wetland	413	0.1
Subtotal	332,924	40.7
Total	**817,370**	**100.0**

Basin Plan Status

The Sacramento and San Joaquin Rivers Basin Plan (Central Valley Water Board 2007b) describes beneficial uses for waters in the Cosumnes River Watershed. Table 3-26 lists the beneficial uses of the Cosumnes River from its source to the Delta.

Table 3-26. Beneficial Uses in the Cosumnes River Watershed

Beneficial Uses	Cosumnes River
Municipal & Domestic	E
Irrigation	E
Stock Watering	E
Process	
Service Supply	
POW (Power)	P
Rec-1*	E
Rec-2*	E
Freshwater Habitat—Warm	E
Freshwater Habitat—Cold	E
Migration—Warm	E
Migration—Cold	E
Spawning—Warm	E
Spawning—Cold	E
Wildlife Habitat	E
Navigation	

P = Potential, E = Existing.

* Rec-1 indicates recreational activities involving body contact with water, where ingestion of the water is reasonably possible. These uses include, but are not limited to, swimming, wading, water skiing, skin and scuba diving, surfing, white water activities, fishing, and use of natural hot springs. Rec-2 indicates recreational activities involving proximity to water, but generally with no body contact with water or any likelihood of ingestion of water. These include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, and aesthetic enjoyment associated with the above activities.

Source: Central Valley Water Board 2007b.

Hydrology

The Cosumnes River originates in the El Dorado National Forest. The upper watershed portion of the Cosumnes River encompasses the North Fork, Middle Fork, and South Fork Cosumnes River (Figure 3-20). The two main tributaries to the Cosumnes River are Deer Creek and Laguna Creek. Portions of the virtually unregulated Cosumnes River are dry in the summer season as many creeks in the Sierra Nevada and the Sacramento Valley are intermittent. During winter, levees provide flood protection along the Cosumnes River in the lower watershed.

Laguna Creek is ephemeral, with several months of little to no flow. Table B-9 in Appendix B contains monthly flows for Laguna Creek. However, flow data are not available for Deer Creek. Flows in the Cosumnes River at Michigan Bar from 1994 to 2004 (Table B-9 in Appendix B) (Station Number 11335000) range from 5 cfs in summer to 7,000 cfs during winter.

Water Quality

There are relatively few water quality concerns in the Cosumnes River. The only known concern in the lower reaches of the river pertains to bioaccumulation of methylmercury. Methylmercury may be mobilized and transported by irrigation return flows; however, it is not directly connected to irrigated agricultural operations. The Cosumnes River is not on the 2006 Section 303(d) list for any stressors and is not significantly affected by irrigated agriculture. The Cosumnes River is one of two remaining significant free-flowing rivers from the Sierra Nevada left in California. While some mining took place upstream, there were no lasting effects on water quality from resource extraction (USGS 2005c). Because of its excellent water quality, the Cosumnes has been used in studies as a reference for unaffected water quality (USGS 2005c).

II.B Delta-Mendota Canal Watershed

General Description

The Delta-Mendota Canal (DMC) Watershed is located in Central California. Its boundaries include the San Joaquin River on the east and the Coast Ranges on the west. To the north lies the Delta, and to the south is the Tulare Lake Basin (Figure 3-2). The DMC Watershed encompasses approximately 1,276,102 acres (1,994 square miles) (DWR 2005c).

The watershed has a minimum elevation of 13 feet, a mean elevation of 750 feet, and a maximum elevation of 3,802 feet (USGS 2005a). The climate is typically Mediterranean, with wet winters and dry summers. Snow may occur in the upper elevations; however, snow does not accumulate in sufficient quantities to provide additional summer flows.

This section describes 17 west side tributaries and agricultural drains that flow to the valley floor section of the San Joaquin River. Like the east side tributaries, the lower portions of these drainages are in the rich agricultural area of the San Joaquin Valley. Generally, the area of irrigated agriculture is located between I-5 and the San Joaquin River, with small patches of irrigated agriculture located on the west side of I-5. (Figure 3-21.)

The drainages in the DMC Watershed from north to south are Ingram Creek, Hospital Creek, Del Puerto Creek, Boundary Drain, Salado Creek, Marshal Road Drain, Ramona Lake, Westly Wasteway, Orestimba Creek, Main Canal, Garzas Creek, Los Banos Creek, Mud Slough, San Luis Drain, Newman Wasteway, Salt Slough, and Island Field Drain.

Land Use Patterns

Native vegetation makes up the majority of land use in the DMC Watershed, totaling almost one-half of the DWR land use coverage and a very large portion of land use coverage in the FRAP vegetation dataset (Table 3-27). Irrigated agriculture makes up the next largest portion of land use in the DMC Watershed, totaling approximately one-third of the land use (Figure 3-33). Generally, I-5 makes up the western boundary for irrigated land, and the San Joaquin River makes up the eastern boundary. A large portion of the DMC Watershed extends up into the Coast Ranges just west of I-5; however, there is virtually no irrigated agriculture in this portion of the watershed. Table 3-27 contains land use acreage according to DWR and FRAP land use data for the DMC Watershed.

Table 3-27. Land Use Acreage according to DWR and FRAP Land Use Data for the Delta-Mendota Canal Watershed

Land Use	Acres	Percent Total
DWR Land Use Type		
Agriculture		
Citrus and Subtropical	745	0.1
Deciduous Fruits and Nuts	52,676	4.8
Field Crops	187,274	17.1
Grain and Hay	17,693	1.6

Land Use	Acres	Percent Total
Idle	3,741	0.3
Pasture	93,061	8.5
Rice	7,760	0.7
Semi agricultural and Incidental	5,902	0.5
Truck, Nursery, and Berry Crops	80,735	7.4
Vineyards	1,388	0.1
Subtotal	450,975	35.4
Urban		
Urban—Unclassified	8,118	0.7
Urban Residential	2,408	0.2
Urban Landscape	664	0.1
Commercial	398	0
Industrial	2,272	0.2
Entry Denied	95	0
Vacant	5,477	0.5
Subtotal	19,432	1.5
Native		
Native Vegetation	600,726	47.1
Riparian Vegetation	1,548	0.1
Water Surface	22,690	2.1
Subtotal	624,964	49.0
FRAP Land Use Type		
Conifer	2.5	0
Hardwood	71,998.80	40.1
Herbaceous	47,323.70	26.4
Shrub	58,818.90	32.8
Urban	1,382.10	0.8
Water	9.9	0
Subtotal	179,536	14.1
Total	**1,274,907**	**100.0**

Basin Plan Status

The Sacramento and San Joaquin Rivers Basin Plan (Central Valley Water Board 2007b) describes beneficial uses for waters in the DMC Watershed. Table 3-28 lists the beneficial uses of the DMC, Mud Slough, Salt Slough, the San Joaquin River from Sack Dam to the mouth of the Merced River, and the San Joaquin River from the Mouth of the Merced River to Vernalis. The beneficial uses of other creeks in the DMC Watershed, such as Del Puerto and Orestimba, have not been specifically identified in the Basin Plan. However, the beneficial uses of any specifically identified water body generally apply to its tributary streams. Consequently, creeks are assigned the same beneficial uses as the two reaches of the San Joaquin River described above. Specifically, Los Banos Creek drains into the San Joaquin River above the Merced River, while the remaining drainages are located on the San Joaquin River between the Merced River and Vernalis.

Table 3-28. Beneficial Uses in the Delta-Mendota Canal Watershed

Beneficial Uses	Delta-Mendota Canal	Mud Slough[a,b]	Salt Slough[b]	SJR (Sack Dam to Mouth of Merced	SJR (Mouth of Merced to Vernalis)
Municipal & Domestic	E			P	P
Irrigation	E	L[a,b]	E	E	E
Stock Watering	E	E	E	E	E
Process				E	E
POW (Power)					
Rec-1*	E	E	E	E	E
Rec-2*	E	E	E	E	E
Freshwater Habitat—Warm	E	E	E	E	E
Freshwater Habitat—Cold					
Migration—Warm		E	E	E	E
Migration—Cold				E	E
Spawning—Warm				E	E
Spawning—Cold				P	
Wildlife Habitat	E	E	E	E	E
Navigation					
COMM		E	E		
BIOL			E		
SHELL		E	E		

P = Potential, E = Existing, L = Existing Limited Beneficial Uses.

COMM = Commercial and Sport Fishing, BIOL = Preservation of biological habitats of special significance, SHELL = Shellfish Harvesting.

* Rec-1 indicates recreational activities involving body contact with water, where ingestion of the water is reasonably possible. These uses include, but are not limited to, swimming, wading, water skiing, skin and scuba diving, surfing, white water activities, fishing, and use of natural hot springs. Rec-2 indicates recreational activities involving proximity to water, but generally with no body contact with water or any likelihood of ingestion of water. These include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, and aesthetic enjoyment associated with the above activities.

[a] Mud Slough North.

[b] Elevated natural salt and boron concentrations may limit this use to irrigation of salt- and boron-tolerant crops. Intermittent low flow conditions also may limit this use.

Source: Central Valley Water Board 2007b.

Hydrology

The unaltered hydrology of the DMC Watershed (Figure 3-21) is dominantly ephemeral; however, most of the tributaries contain flow year-round due to agricultural return flows. During the storm season, the small drainages that comprise the DMC Watershed contain intermittent flows that reflect the intensity and duration of storms. The DMC Watershed is highly manipulated, with many canals delivering water to agricultural operations and back to the natural drainages. Flow data were available on the USGS website for some tributaries located in the DMC Watershed. Table B-10 in Appendix B contains monthly average minimum, mean, and maximum flows for Del Puerto Creek, Orestimba Creek, Mud Slough, San Luis Drain, and Salt Slough. Generally flows in the west side drainages are much lower than flows in the larger east side tributaries.

The DMC is part of the Central Valley Project (CVP); it starts at the Tracy Pumping Plant near Tracy and continues south to the Mendota Pool on the San Joaquin River. The majority of water deliveries through the DMC are for use by the San Joaquin River Exchange Contractors Water Authority (SJRECWA). The SJRWECWA consists of four irrigation districts who exchanged San Joaquin River Water for water pumped from the Delta. The water quality of the San Joaquin River is markedly different than that of the DMC primarily due to the agricultural return flows that drain into the San Joaquin River prior to the Stockton Deep Water Ship Channel, including the elevated salt loads received from Mud Slough and Salt Slough.

From the Mendota Pool, water is delivered via canal to the service areas of the Central California Irrigation District (CCID), the Firebaugh Canal Water District, the Columbia Canal Company, and the San Luis Canal Company. San Luis Canal Company deliveries are made 22 miles downstream of the Mendota Pool at Sack Dam on the San Joaquin River. No flow is released from Sack Dam into the lower portions of the San Joaquin River, except during extreme storm events. This water is again introduced into the San Joaquin River as drainage through various west side streams and built facilities. The water quality of the DMC is representative of south Delta water quality and has agricultural beneficial uses.

Water Quality

The water quality conditions in water bodies of the DMC Watershed are dominated by agricultural return flows during the dry season, which often transport pesticides to the San Joaquin River. In addition, pesticides are applied during the dormant spray season, which typically occurs between November and January, and can be transported to water bodies during rainfall events. Data indicate that chlorpyrifos, diazinon, parathion methyl, dieldrin, demeton, methomyl, azinphos-methyl, simazine, dimethoate, malathion, DDE, DDT, and DDD are present in concentrations that exceed water quality objectives (see Appendix C for water quality objectives) and are known to be associated with agricultural operations (Central Valley Water Board 2007a; Kratzer et al. 2002, 2004; Zamora et al. 2003; USGS 2005b, 2005c). Copper also has been detected at multiple locations in the DMC Watershed. Copper is a naturally occurring metal that is also used as a pesticide. Other naturally occurring metals such as arsenic, cadmium, boron, nickel, lead, and selenium also have been detected at elevated levels and are mobilized and suspended in agricultural return flows throughout the DMC Watershed (Central Valley Water Board 2007a).

Many of the creeks located in the DMC Watershed contain low DO. Factors contributing to low DO are still under investigation; however, nutrient loads from irrigated agriculture have been correlated with low DO in the San Joaquin River Basin (Kratzer et al. 2004). Many of the creeks in the DMC Watershed also have experienced fluctuating pH and elevated levels of EC (Central Valley Water Board 2007a).

Table 3-29 summarizes the contaminants with one or more elevated concentration above the applicable water quality objective, as well as other water quality parameters that may not meet the respective variable objectives. The table cites the known source of the contaminants, and if it is connected to irrigated agriculture. In addition, the creeks and agriculture drains that this table represents are included in the notes at the bottom of the table.

Toxicity tests and TIEs were performed for ILRP monitoring in an attempt to identify the causes of water toxicity in the test organisms. The results indicated that non-polar organics such as organophosphate insecticides (e.g., chlorpyrifos, diazinon, and parathion methyl) strongly point to the large toxicity problem in the DMC Watershed (see Table 3-29) (Central Valley Water Board 2007a).

Table 3-29. Known Agricultural Contaminants and Conditions That Affect Water Quality in the Delta-Mendota Canal Watershed

Parameter	Potential Agricultural Source/Contribution to Water Quality Impairment	Sources
Chlorpyrifos	Pesticide used to protect agricultural crops	1, 2, 3, 5
Diazinon	Pesticide used to protect agricultural crops	1, 2, 3, 5
Parathion methyl	Pesticide used to protect agricultural crops	1
Dieldrin	Pesticide used to protect agricultural crops	1
Demeton	Pesticide used to protect agricultural crops	1
Methomyl	Pesticide used to protect agricultural crops	1
Azinphos-methyl	Pesticide used to protect agricultural crops	4, 5
Simazine	Pesticide used to protect agricultural crops	1
Dimethoate	Pesticide used to protect agricultural crops	1
Malathion	Pesticide used to protect agricultural crops	1
DDE	Legacy pesticide potentially mobilized by irrigated agricultural operations	1, 5
DDT	Legacy pesticide potentially mobilized by irrigated agricultural operations	1
DDD	Legacy pesticide potentially mobilized by irrigated agricultural operations	1
Arsenic	Naturally occurring metal that is partly mobilized and concentrated by irrigated agriculture, causing toxic levels in receiving waters	1
Cadmium	Naturally occurring metal that is partly mobilized and concentrated by irrigated agriculture, causing toxic levels in receiving waters	1
Boron	Naturally occurring metal that is partly mobilized and concentrated by irrigated agriculture, causing toxic levels in receiving waters	1, 5
Nickel	Naturally occurring metal that is partly mobilized and concentrated by irrigated agriculture, causing toxic levels in receiving waters	1
Copper	Occurs naturally but is also used as a pesticide	1
Lead	Naturally occurring metal that is partly mobilized and concentrated by irrigated agriculture, causing toxic levels in receiving waters	1
Selenium	Naturally occurring metal that is partly mobilized and concentrated by irrigated agriculture, causing toxic levels in receiving waters	1, 5
Bacteria	Likely a result of animal confinement facilities land application of waste	1
DO	Factors contributing to low DO are under investigation. Nutrient loads from irrigated lands may be connected to low DO.	1, 6
EC	Factors contributing to high EC may involve elevated levels of salt on irrigated land.	1
pH	Factors contributing to high pH are under investigation.	1

Parameter	Potential Agricultural Source/Contribution to Water Quality Impairment	Sources
Toxicity (minnow, flea, algae, sediment)	Toxicity identification evaluations (TIEs) strongly point to organophosphate insecticides (e.g., chlorpyrifos and diazinon) being linked to much of the observed water toxicity. TIEs also indicate that bifenthrin and lambda-cyhalothrin are associated with much of the observed sediment toxicity in the DMC Watershed.	1,7

Sources:

[1] Central Valley Water Board 2007a.
[2] Kratzer et al. 2002.
[3] Zamora et al. 2003.
[4] USGS 2005c.
[5] USGS 2005b.
[6] Kratzer et al. 2004.
[7] Weston et al. In Press.

Note: Water bodies in the DMC Watershed that are impacted by one or more of the contaminants listed in this table include Del Puerto Creek, Ingram Creek, Hospital Creek, Boundary Drain, Salado Creek, Marshal Road Drain, Ramona Lake, Westley Wasteway, Island Field Drain, Orestimba Creek, Main Canal, Garzas Creek, Mud Slough, San Luis Drain, Newman Wasteway, and Salt Slough.

II.C San Joaquin River Watershed

General Description

The San Joaquin River Watershed is located in the southeastern portion of the Central Valley and extends up into the Sierra Nevada (Figure 3-2). The San Joaquin River Watershed covers approximately 1,091,883 acres (1,706 square miles) from the headwaters of the San Joaquin River high in the Sierra Nevada Mountains down to the edge of the valley floor. The watershed extends downstream to Millerton Lake. To the north are the Merced and Fresno Rivers, to the south is the Kings River, on the east are the Sierra Nevada Mountains, and on the west is the valley floor (Figure 3-22). Elevations range from 315 to 13,920 feet, the highest elevation in the larger San Joaquin River Basin. (USGS 2005a) The climate of the San Joaquin watershed varies greatly because of the large range in elevation. At the lower elevations, the climate is arid to semi-arid with dry, hot summers and mild winters. Summer temperatures may be higher than 100°F, and winter temperatures are only occasionally below freezing. Conditions are cooler and there is more precipitation at the higher elevations. The winter snowpack, which accumulates above 5,000 feet elevation, supplies much of the water in this watershed.

Land Use Patterns

Native vegetation is the primary land use type in the San Joaquin River Watershed (Figure 3-34). Urban land and agriculture each make up less than 1 percent of the land use in the watershed (Table 3-30). Table 3-30 shows land use acreage according to DWR and FRAP land use data for the San Joaquin River Watershed.

Table 3-30. Land Use Acreage according to DWR and FRAP Land Use Data for the San Joaquin River Watershed

Land Use	Acres	Percent Total
DWR Land Use Type		
Agriculture		
Deciduous Fruits and Nuts	46	0.0
Semi agricultural and Incidental	1	0.0
Subtotal	47	0.0
Urban		
Urban—Unclassified	36	0.0
Urban Landscape	115	0.0
Urban Residential	39	0.0
Commercial	16	0.0
Vacant	29	0.0
Subtotal	235	0.0
Native		
Native Vegetation	43,540	4.0
Water Surface	2,322	0.2
Subtotal	45,862	4.2

Land Use	Acres	Percent Total
FRAP Land Use Type		
Agriculture	158	0.0
Barren/Other	179,489	16.4
Conifer	606,023	55.5
Hardwood	142,167	13.0
Herbaceous	23,786	2.2
Shrub	61,400	5.6
Urban	1,634	0.2
Water	21,960	2.0
Wetland	9,123	0.8
Subtotal	1,045,740	95.7
Total	**1,091,883**	**100.0**

Basin Plan Status

The Sacramento and San Joaquin Rivers Basin Plan (Central Valley Water Board 2007b) describes beneficial uses for waters in the San Joaquin River Watershed. Table 3-31 lists the beneficial uses of the Upper San Joaquin River from its sources to Millerton Lake (including Millerton Lake).

Table 3-31. Beneficial Uses in the San Joaquin River Watershed

Beneficial Uses	Upper San Joaquin River (from source to Millerton Lake)
Municipal & Domestic	E
Irrigation	E
Stock Watering	E
Process	
POW (Power)	E
Rec-1*	E
Rec-2*	E
Freshwater Habitat—Warm	E
Freshwater Habitat—Cold	E
Migration—Warm	
Migration—Cold	
Spawning—Warm	
Spawning—Cold	
Wildlife Habitat	E
Navigation	

P = Potential, E = Existing.

COMM = Commercial & Sport Fishing. BIOL = Preservation of biological habitats. SHELL = Shell fish harvesting.

* Rec-1 indicates recreational activities involving body contact with water, where ingestion of the water is reasonably possible. These uses include, but are not limited to, swimming, wading, water skiing, skin and scuba diving, surfing, white water activities, fishing, and use of natural hot springs. Rec-2 indicates recreational activities involving proximity to water, but generally with no body contact with water or any likelihood of ingestion of water. These include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, and aesthetic enjoyment associated with the above activities.

Source: Central Valley Water Board 2007b

Hydrology

The San Joaquin River Watershed includes the Upper San Joaquin River from its sources in the southern Sierra Nevada to, and including, Millerton Lake and many tributaries. Millerton Lake and Friant Dam are owned and operated by Reclamation mainly for flood control and water supply purposes (Reclamation 2003).

There are many other dams and reservoirs located on the Upper San Joaquin River and its tributaries. PG&E and Southern California Edison operate these facilities for hydroelectric power and to meet downstream flow requirements. Reservoirs upstream of Millerton Lake include Shaver Lake on Stevenson Creek; Huntington Lake on Big Creek; Florence Lake on the South Fork San Joaquin River; Lake Thomas A. Edison on Mono Creek; and Mammoth Pool Reservoir, Redinger Lake, and Kerckhoff Lake all on the San Joaquin River. Bass Lake, on the North Fork of Willow Creek, can export water to the Fresno River, which is located outside of the San Joaquin River Watershed.

Inflow into Millerton Lake is influenced by the operation of the upstream reservoirs. The largest inflows occur in the late spring and early summer. On average, June receives the highest average inflow, at 5,661 cfs (CDEC Station SJA). The lowest average inflow occurs in November at 1,077 cfs. Table B-11 in Appendix B contains average monthly flow data for the San Joaquin River near Auberry.

Water Quality

There are few water quality concerns in the Upper San Joaquin River, and water quality conditions are not affected by irrigated agriculture. No 2006 Section 303(d)-listed pollutants are associated with the Upper San Joaquin River or its tributaries. This is likely due to the native vegetation and low occurrence of urban, industrial, irrigated agriculture, or other developed land uses in this watershed.

II.D San Joaquin Valley Floor Watershed

General Description

The San Joaquin Valley Floor Watershed (SJVF Watershed) is located between the lower portion of the San Joaquin River and the Stanislaus River confluence in the Central Valley; the watershed covers approximately 1,792,389 acres (2,801 square miles) (Figure 3-2). Specifically, the SJVF Watershed extends from north of the Stanislaus River south to the section of the San Joaquin River between Friant Dam and the Mendota Pool. From west to east, it extends from the San Joaquin River to the Sierra Nevada foothills (Figure 3-23). Six major eastside tributaries to the San Joaquin River are considered in this section. From north to south, they are the Stanislaus River, the Tuolumne River, the Merced River, Bear Creek, the Chowchilla River, the Fresno River, and the San Joaquin River. Smaller tributaries and drains also are discussed.

The climate of the SJVF Watershed is arid to semi-arid with dry, hot summers and mild winters. Summer temperatures may be higher than 100°F for extended periods; winter temperatures are only occasionally below freezing (Jones & Stokes 1998). The region averages less than 10 inches of annual rainfall along State Route (SR) 99. The winter snowpack, which accumulates above 5,000 feet elevation (outside of this watershed) primarily in the Sierra Nevada, supplies the vast majority of water in the basin. Elevations in this watershed range from approximately 0 to 1,000 feet.

Land Use Patterns

Agriculture represents more than half of the land use in the SJVF Watershed (Figure 3-35). Native vegetation, which is predominantly in the eastern portion of the watershed, occupies about a third of the land use in the watershed.

Table 3-32 shows the land use acreage according to DWR and FRAP land use data for the SJVF Watershed. Almost all of the agricultural land is irrigated, although pastureland and certain crops such as wheat and safflower may not require irrigation. In addition, pasture may or may not be irrigated.

Table 3-32. Land Use Acreage according to DWR and FRAP Land Use Data for the San Joaquin Valley Floor Watershed

Land Use	Acres	Percent Total
DWR Land Use Type		
Agriculture		
Citrus and Subtropical	7,769	0.4
Deciduous Fruits and Nuts	371,893	20.7
Field Crops	225,157	12.6
Grain and Hay	57,454	3.2
Idle	14,019	0.8
Pasture	222,894	12.4
Rice	9,697	0.5
Semi agricultural and Incidental	35,605	2.0

Land Use	Acres	Percent Total
Truck, Nursery, and Berry Crops	41,189	2.3
Vineyards	140,922	7.9
Subtotal	1,126,599	62.8
Urban		
Urban—Unclassified	76,018	4.2
Urban Landscape	6,027	0.3
Urban Residential	22,313	1.2
Industrial	8,947	0.5
Commercial	2,424	0.1
Vacant	18,779	1.0
Subtotal	134,508	7.3
Native		
Native Vegetation	513,722	28.7
Barren and Wasteland	32	0.0
Riparian Vegetation	2,499	0.1
Water Surface	15,018	0.8
Subtotal	531,271	29.6
Not Surveyed	7	0.0
FRAP Land Use Type		
Pasture	0.14	0.0
Native Vegetation	0.03	0.0
Subtotal	0.17	0.0
Total	**1,792,389**	**100**

Basin Plan Status

The Sacramento and San Joaquin Rivers Basin Plan (Central Valley Water Board 2007b) describes beneficial uses for waters in the SJVF Watershed. Table 3-33 lists the beneficial uses of the lower Stanislaus River (Goodwin Dam to San Joaquin River), Tuolumne River (New Don Pedro Dam to San Joaquin River), Merced River (McSwain Reservoir to San Joaquin River), Chowchilla River (Buchanan Dam to San Joaquin River), and Fresno River (Hidden Dam to the San Joaquin River). The table also includes beneficial uses for four sections of the San Joaquin River. The Basin Plan does not list irrigation as a beneficial use for the Merced River downstream of McSwain Reservoir even though some large agricultural diversions are downstream of McSwain Dam.

Table 3-33. Beneficial Uses by River in the San Joaquin Valley Floor Watershed

Beneficial Uses	Stanislaus River	Tuolumne River	Merced River	Yosemite Lake	Chowchilla River	Fresno River	San Joaquin River, Friant Dam to Mendota Pool	San Joaquin River, Mendota Dam to Sack Dam	San Joaquin River, Sack Dam to Merced River	San Joaquin River, Merced River to Vernalis
Municipal and Domestic	P	P	E		P	P	E	P	P	P
Irrigation	E	E			E	E	E	E	E	E
Stock Watering	E	E	E			E	E	E	E	E
Process	E		E		E		E	E	E	E
Service Supply	E		E							
Hydropower	E		E							
Rec-1*	E	E	E	E	E	E	E	E	E	E
Rec-2*	E	E	E	E	E	E	E	E	E	E
Freshwater Habitat—Warm	E	E	E	E	E	E	E	E	E	E
Freshwater Habitat—Cold	E	E	E	E			E			
Migration—Warm			E				E	E	E	E
Migration—Cold	E	E	E				E	E	E	E
Spawning—Warm	E	E	E				E	E	E	E
Spawning—Cold	E	E	E				P	P	P	
Wildlife Habitat	E	E	E	E	E	E	E	E	E	E
Navigation										

P = Potential, E = Existing.

Process is industrial use that depends on water quality.

Service supply is industrial use that is not dependent on water quality.

* Rec-1 indicates recreational activities involving body contact with water, where ingestion of the water is reasonably possible. These uses include, but are not limited to, swimming, wading, water skiing, skin and scuba diving, surfing, white water activities, fishing, and use of natural hot springs. Rec-2 indicates recreational activities involving proximity to water, but generally with no body contact with water or any likelihood of ingestion of water. These include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, and aesthetic enjoyment associated with the above activities.

Source: Central Valley Water Board 2007b.

Hydrology

There are six major east side tributaries along with many smaller tributaries and drains in the SJVF Watershed (Figure 3-23). The eight major east side tributaries from north to south include the Stanislaus River, the Tuolumne River, Dry Creek, Merced River, Bear Creek, Chowchilla River, the Fresno River, and the San Joaquin River.

Stanislaus River

The Stanislaus River forms the northern boundary of Stanislaus and Tuolumne Counties and flows near the cities of Ripon, Riverbank, and Oakdale (Figure 3-23). It drains an area of about 1,075 square miles at its intersection with SR 99, about 15 river miles upstream of its confluence with the San Joaquin River.

Table B-12 in Appendix B shows minimum, mean, and maximum monthly average flows recorded at several flow stations along the Stanislaus River from 1995 to 2004. The USGS flow records show that flows at the New Melones Powerhouse are similar to those at Goodwin Dam during November–February; but during much of the rest of the year, flows at Goodwin Dam are less than at the powerhouse because of agricultural diversions. Flows at Ripon are only slightly greater (by an average of about 100 cfs) than those below Goodwin Dam. Monthly average flows at Ripon varied between approximately 300 and 6,500 cfs.

Tuolumne River and Dry Creek

The Tuolumne River flows from its headwaters in Tuolumne County through Stanislaus County. It passes by the city of Modesto and then, approximately 15 river miles from Modesto, enters the San Joaquin River. At Modesto, the Tuolumne River drains a watershed of approximately 1,900 square miles.

Dry Creek is a moderate-size tributary to the lower section of the Tuolumne River. It enters the river at the city of Modesto approximately 0.2 miles upstream of the USGS Tuolumne River flow gauge at Modesto. Dry Creek drains an area of about 190 square miles (City of Modesto 2003a). While Dry Creek flows are usually not large, except from major winter/spring storm events, they carry runoff from agricultural lands and dairies and storm season runoff from the City of Modesto (East San Joaquin County Water Quality Coalition 2004). Flows from Dry Creek generally contribute less than half of the flow gains in the Tuolumne River between La Grange and Modesto. Flow data for the Tuolumne River and Dry Creek are included in Table B-13 in Appendix B. Tuolumne River flows near Modesto range from approximately 200 cfs during the dry season up to approximately 15,000 cfs during the storm season. Dry Creek flows range from as low as 1 cfs to up to approximately 1,000 cfs during the storm season.

Merced River

The Merced River drains an approximately 1,276-square mile watershed just south of the Tuolumne River. Exchequer Dam forms Lake McClure, the largest reservoir on the Merced River, with a capacity of 1,046,000 acre-feet and a watershed of approximately 1,037 square miles. Downstream of Lake McClure, McSwain Dam forms Lake McSwain.

Downstream of Lake McSwain, Merced Falls Dam impounds water to be diverted into the North Side Canal for delivery to agricultural land. The largest water diversion occurs above Crocker-Huffman Dam, where water enters the Merced ID's Main Canal. This diversion accounts for the majority of the flow reduction between the Merced River below Merced Falls and the Merced River at Cressy. Flow data for the Merced River are included in Table B-14 in Appendix B. Seven private diversion ditches in the Snelling area also divert water for agricultural use to about 22,000 acres. A survey by DFG identified 244 diversions, mostly pumps, along the Merced River that predominately supply water for agricultural use.

The portion of the Merced River that falls in the SJVF Watershed extends from Merced Falls Dam downstream to the San Joaquin River. This portion of the Merced River is dominated by agricultural land use.

Small amounts of water are returned to the river downstream of Crocker-Huffman Dam at the North Side Canal spill; Livingston Canal spill; Highline Canal spill; Merced ID Garibaldi Lateral; Turlock Irrigation District (TID); Lower Stevinson Canal; Stevinson East Side Canal; and many smaller, private drains. A unique feature of the East Side Canal is that it intercepts, directly or indirectly, all creeks south of the Merced River and north of the Chowchilla River.

Of these agricultural return flows, the Highline Canal may be the most contaminated. Flows from the Livingston Canal during winter are dominated by urban runoff from the City of Atwater and the Town of Winton. Agricultural return flows are part of the reason that flows in the Merced River near Stevinson are sometimes greater than the flows in the Merced River near Cressy, approximately 23 miles upstream. Table B-14 in Appendix B contains flow data for the Merced River. During the summer of 3 of the last 5 years, flows were consistently greater at Stevinson than at Cressy. During winter, rainfall causes local inflows.

The Corps operates flood control reservoirs on Bear, Burns, and Canal Creeks as part of the Merced County Streams Group. Diversion channels for Miles Creek and the Black Rascal Creek Diversion also are part of the Merced County Streams Group.

Bear Creek

Bear Creek originates much lower in the Sierra Nevada than the Stanislaus, Tuolumne, and Merced Rivers. It starts in Mariposa County near the town of Bear Valley, which is at 2,050 feet elevation. Just before entering Merced County, Bear Creek flows through Bear Reservoir, a small flood control reservoir operated by the Corps. Flows are discharged from the reservoir via an ungated outlet. Flow data for Bear Creek is included in Table B-15 in Appendix B. Flows range from as little as 1 to as much as 1,300 cfs during the storm season.

Chowchilla River

Eastman Lake, formed by Buchanan Dam, is the only large reservoir in the Chowchilla River watershed. It has a capacity of 150,000 acre-feet, and its watershed area is 235 square miles. Eastman Lake is operated by the Corps. The only currently operated measurement station along the Chowchilla River is the CDEC station at Eastman Lake. Releases from the lake are shown in Table B-16 in Appendix B. Flow ranges from 0 to 7,000 cfs.

The lower Chowchilla River is north of the town of Chowchilla. Upstream of the town of Chowchilla, water is diverted south from the Chowchilla River to supply Barenda and Ash Sloughs (Vollmar 2001). Downstream of the town of Chowchilla (to the west), the Chowchilla River enters the East Side Bypass, which eventually flows into the San Joaquin River. The Chowchilla Water District (CWD) diverts water for agricultural use along the river. CWD operates two canals that spill to Merced ID’s El Nido Canal.

Fresno River

Mostly dominated by rainfall, the Fresno River watershed is 500 square miles located at a relatively low elevation in Madera County. Hensley Lake, formed by Hidden Dam, is the only large reservoir in the Fresno River watershed. It is operated by the Corps and has a capacity of 90,000 acre-feet. The watershed area of the lake is approximately 237 square miles (Bookman-Edmonston 2003). The Madera ID obtains some of its water from the Fresno River. Historically, the Fresno River has had ephemeral flows consisting of large winter floods and no summer flows (Bookman-Edmonston 2003). The Madera Canal, operated by the Friant Water Users Association under contract from Reclamation, can spill water to the Fresno River when necessary. The Madera Canal originates at Friant Dam and delivers San Joaquin River water to contractors in the Madera and Chowchilla Water Districts.

The only currently operated measurement station along the Fresno River is the CDEC station at Hensley Lake. Releases from the lake are shown in Table B-17 in Appendix B. Flows range from 0 to 1,500 cfs.

San Joaquin River

The San Joaquin River between Friant Dam and the Delta forms the western and southern boundaries of the SJVF Watershed. The following description extends to the San Joaquin River at Vernalis, which is the sampling location upstream of any tidal influence from the Delta. Although Vernalis is about 2 miles north of the SJVF Watershed boundary, it is included with the valley floor description because Vernalis is a key water quality measurement location that represents the cumulative water quality conditions resulting from all the upstream inflows.

Most of the runoff stored in Millerton Lake is diverted south in the Friant-Kern Canal for agricultural use and is not conveyed down the San Joaquin River. Releases of about 150 cfs are made to the river to satisfy downstream water rights; consequently, the river is normally dry between Gravelly Ford (RM 229) and Mendota Pool (RM 206) except during flood operations. Water imported via the DMC is diverted into several irrigation canals from the Mendota Pool, with a portion of the flow remaining in the San Joaquin River to provide flows between Mendota Dam (RM 204.6) and Sack Dam (RM 182.1). Flows are then diverted into the Arroyo Canal by the Columbia Canal Company to serve irrigated agriculture and wetland demands. The river is again dewatered as far as the Sand Slough Control Structure (RM 168.5) in most years. Agricultural tailwater and groundwater seepage provide some flow downstream of the Sand Slough Control Structure. Flows remain low until the river passes the city of Stevinson and reaches Salt Slough and Mud Slough, which have fairly reliable flows during summer that are attributable to agriculture and wetland return flows. Just downstream of Salt Slough and Mud Slough, the flow is greatly increased at the confluence with the Merced River. According to USGS flow records of 1951 to 1995, 66 percent of the average flow at the downstream end of the San Joaquin River comes from three major east side river basins: the Merced River (15 percent), the Tuolumne River (30 percent), and the Stanislaus River (21 percent) (Kratzer 2002).

The variability in flows along the length of the San Joaquin River is presented in Table B-18 in Appendix B. All of these measurements are in areas of consistent flow. Releases from Friant Dam are generally greater than 100 cfs. The flows measured near Mendota are between Mendota Pool and Sack Dam, and are sustained by DMC flows into Mendota Pool. The Fremont Ford Bridge flows are sustained by flows from Salt Slough. Because Crows Landing is downstream of Mud Slough, the Merced River, and Orestimba Creek, flows are considerably higher. They are highest at Vernalis, which is downstream of all major inflows.

Other Drainages

In the SJVF Watershed area, multiple small drainages flow directly into the San Joaquin River. Water quality concerns have been identified for several of these, including Harding Drain and August Road Drain at Crows Landing. Both of these drains are located between the Merced and Tuolumne Rivers; the Harding Drain is north of the August Road Drain. Harding Drain, sometimes referred to incorrectly as TID Lateral Number 5, conveys agricultural runoff as well as discharge from the City of Turlock's wastewater treatment plant (TID 2005). Canal Creek (flows to Bear Creek), Miles Creek (flows to Owens Creek) and Owens Creek (flows to East Side Canal) also are present in the SJVF Watershed area. The Planada Community Services District discharges urban runoff and treated effluent to Miles Creek. The Le Grand Community Service District discharges urban runoff and treated effluent to Mariposa Creek.

Dutchman Creek and Duck Slough are two other small waterways with water quality issues. Dutchman Creek and Duck Slough are located between Bear Creek and the Chowchilla River. Dutchman Creek flows into Deadman Creek, which joins with Duck Slough at its downstream end.

Water Quality

The water quality of the SJVF Watershed is dominated by agricultural return flows during the dry season, which frequently transport pesticides to the San Joaquin River. In addition, pesticides are applied during the dormant spray season, which typically occurs between November and January, and can be transported to water bodies during rainfall events. Data indicate that chlorpyrifos, diazinon, thiobencarb, dieldrin, DDT, and DDD have been detected in one or more water bodies in concentrations that exceed water quality objectives (see Appendix C for water quality objectives and Table 3-34 for the constituents that exceeded these objectives) and are known to be associated with agricultural operations (Central Valley Water Board 2007a; Kratzer et al. 2002, 2004; Zamora et al. 2003; USGS 2005b, 2005c; Weston et al. In Press). Copper also has been detected at multiple locations in the SJVF Watershed. Copper is a naturally occurring metal that is also used as a pesticide. Other metals such as cadmium, boron, and lead have been detected at elevated levels and are mobilized and suspended in agricultural return flows throughout the SJVF Watershed (Central Valley Water Board 2007a).

Many of the rivers and agriculture drainages located in the SJVF Watershed contain low DO. Factors contributing to low DO are still under investigation; however, nutrient loads from irrigated agriculture and animal confinement facilities have been correlated to low DO in the San Joaquin River Basin (Kratzer et al. 2004). Many of the creeks in the SJVF Watershed also have experienced fluctuating levels of pH and elevated levels of EC (Central Valley Water Board 2007a). Table 3-34 summarizes all the contaminants with one or more elevated concentrations above the applicable water quality objective.

TIEs were performed to attempt to connect the toxicity results to a particular pesticide. TIEs were performed in most cases on the water samples that exceeded 50 percent mortality. The results indicated that non-polar organics such as organophosphate insecticides (e.g., chlorpyrifos, diazinon, and parathion methyl) may be causing the large toxicity problem in the SJVF Watershed (see Table 3-34) (Central Valley Water Board 2007a).

Table 3-34. Known Agricultural Contaminants and Conditions That Affect Water Quality in the San Joaquin Valley Floor Watershed

Parameter	Potential Agricultural Sources/Contribution to Water Quality Impairment	Sources
Chlorpyrifos	Pesticide used to protect agricultural crops	1, 2, 3, 4
Diazinon	Pesticide used to protect agricultural crops	1, 2, 3, 4
Thiobencarb	Pesticide used to protect agricultural crops	1
Malathion	Pesticide used to protect agricultural crops	1
Dieldrin	Pesticide used to protect agricultural crops	4
DDT	Legacy pesticide potentially mobilized by irrigated agricultural operations	1
DDD	Legacy pesticide potentially mobilized by irrigated agricultural operations	1
Copper	Occurs naturally but is also used as a pesticide	1
Boron	Naturally occurring metal that is partly mobilized and concentrated by irrigated agriculture, causing toxic levels in receiving waters	4
Cadmium	Naturally occurring metal that is partly mobilized and concentrated by irrigated agriculture, causing toxic levels in receiving waters	1
Lead	Naturally occurring metal that is partly mobilized and concentrated by irrigated agriculture, causing toxic levels in receiving waters	1
Bacteria	Likely a result of animal confinement facilities land application of waste	1
DO	Factors contributing to low DO are under investigation. Nutrient loads from irrigated lands may be connected to low DO.	1, 5
EC	Factors contributing to high EC may involve elevated levels of salt on irrigated land.	1
pH	Factors contributing to high pH are under investigation.	1
Toxicity (minnow, flea, algae, sediment)	Toxicity identification evaluations (TIEs) strongly suggest organophosphate insecticides (e.g., chlorpyrifos and diazinon) as the cause of minnow toxicity, algae toxicity, and water flea toxicity. TIEs also indicate that bifenthrin and lambda-cyhalothrin are associated with much of the observed sediment toxicity in the SJVF Watershed.	1, 6

Sources:
[1] Central Valley Water Board 2007a.
[2] Kratzer et al. 2002.
[3] Zamora et al. 2003.
[4] USGS 2005b, 2005c.
[5] Kratzer et al. 2004.
[6] Weston et al. In Press.

Note: Water bodies in the SJVF Watershed that are impacted by one or more of the contaminants listed in this table include the Stanislaus River, the Tuolumne River, the Merced River, Bear Creek, the Chowchilla River, the Fresno River, and the San Joaquin River. Smaller tributaries and drains include Ash Slough, August Road Drain, Brenda Slough, Black Rascal Creek, Deadman Creek, Dry Creek, Duck Slough, Highline Canal, Jones Drain, Lone Willow Slough, Prairie Flower Drain, Silva Drain, and Cottonwood Creek.

II.E Delta-Carbona Watershed

General Description

The Delta-Carbona Watershed is located within Contra Costa, Alameda, and San Joaquin Counties near the western margin of the Central Valley and east of San Francisco Bay (Figure 3-2). It encompasses most of the Delta, with an area of approximately 664,759 acres (1,039 square miles). The elevation ranges from –20 to 3,832 feet (USGS 2005a). The San Joaquin River and the North Mokelumne River form the northwestern boundary (Figure 3-24). The eastern boundary is located along Interstate 5 (I-5) east of the San Joaquin River. The watershed extends as far south as the Stanislaus River. The western boundary of the Delta-Carbona Watershed is on the inland edge of the Coast Ranges.

The climate of the Delta-Carbona Watershed is arid to semi-arid with dry, hot summers and mild winters. Summer temperatures may be higher than 100°F, and winter temperatures are only occasionally below freezing. The Delta weather conditions are more moderate than in the rest of the Central Valley because of the moderating effect of the proximity of the Pacific Ocean. The winter snowpack that accumulates above 5,000 feet elevation primarily in the Sierra Nevada (which is outside of this watershed) supplies the vast majority of water in the basin.

The Delta is a complex web of waterways winding among agricultural islands that are close to or below sea level. Flows and water quality in the Delta are influenced primarily by:

- major inflows—the San Joaquin River, the Sacramento River, and ocean tides;
- major outflows—exports to the California Aqueduct at the Banks Pumping Plant and to the DMC at the Jones (Tracy) pumping plant;
- channel structure—channel dimensions and slope as well as the use of gates and construction of barriers such as the one used at the head of Old River to redirect flow to the mainstem San Joaquin River during certain times of the year; and
- Delta Cross Channel—diverts flows from the Sacramento River to Snodgrass Slough and the Mokelumne River to decrease salinity levels at the state and federal pumping plants.

Smaller inflows and diversions (such as Marsh Creek, the Calaveras River, the Mokelumne River, and agricultural diversions and returns) also play a role in influencing flow and water quality. Although the Sacramento River is a major contributor to Delta flow and water quality, it is not within the Delta-Carbona Watershed and therefore is not described in this section.

The Contra Costa Water District straddles the western edge of the Delta-Carbona Watershed. This water district obtains drinking water from the Delta and is vigilant about Delta water quality. The West Side ID, the Plain View Water District, and the Banta-Carbona ID all operate within the southern portion of the Delta-Carbona Watershed.

There are numerous waterways in the Delta-Carbona Watershed. Some of the larger ones, or ones that are of particular water quality concern, are described in the hydrology section.

Land Use Patterns

Irrigated agriculture is the primary land use type in the Delta-Carbona Watershed, encompassing almost half of the land use acreage (Figure 3-36). Native vegetation covers about one-third of the watershed, and urban land use represents about one-tenth of the land use in the watershed. Table 3-35 lists land use acreage according to DWR and FRAP land use data for the Delta-Carbona Watershed.

Table 3-35. Land Use Acreage according to DWR and FRAP Land Use Data for the Delta-Carbona Watershed

Land Use	Acres	Percent Total
DWR Land Use Type		
Agriculture		
Citrus and Subtropical	54	0.0
Deciduous Fruits and Nuts	17,956	2.7
Field Crops	106355	16.0
Grain and Hay	47,504	7.1
Idle	5,608	0.8
Pasture	61,451	9.2
Rice	801	0.1
Semi agricultural and Incidental	3916	0.6
Truck, Nursery, and Berry Crops	62,539	9.4
Vineyards	8,637	1.3
Subtotal	314,821	47.4
Urban		
Urban—Unclassified	53,940	8.1
Urban Landscape	2,209	0.3
Urban Residential	3,539	0.5
Commercial	902	0.1
Industrial	6,707	1.0
Vacant	9,284	1.4
Subtotal	76,581	11.5
Native		
Barren and Wasteland	60	0.0
Native Vegetation	177,507	26.7
Riparian Vegetation	8,713	1.3
Water Surface	41,948	6.3
Subtotal	228,228	34.3
FRAP Land Use Type		
Agriculture	2,598	0.4
Hardwood	5,667	0.9
Herbaceous	35,212	5.3
Shrub	138	0.0
Urban	1,235	0.2
Water	269	0.0

Land Use	Acres	Percent Total
Wetland	10	0.0
Subtotal	45,129	6.8
Total	**664,759**	**100**

Basin Plan Status

The Sacramento and San Joaquin Rivers Basin Plan (Central Valley Water Board 2007b) describes beneficial uses for waters in the Delta-Carbona Watershed. Table 3-36 lists the beneficial uses in the Delta.

Table 3-36. Beneficial Uses in the Delta-Carbona Watershed

Beneficial Uses	Sacramento–San Joaquin River Delta
Municipal & Domestic	E
Irrigation	E
Stock Watering	E
Process	E
Service Supply	E
Power	
Rec-1*	E
Rec-2*	E
Freshwater Habitat—Warm	E
Freshwater Habitat—Cold	E
Migration—Warm	E
Migration—Cold	E
Spawning—Warm	E
Spawning—Cold	
Wildlife Habitat	E
Navigation	E

P = Potential, E = Existing.

* Rec-1 indicates recreational activities involving body contact with water, where ingestion of the water is reasonably possible. These uses include, but are not limited to, swimming, wading, water skiing, skin and scuba diving, surfing, white water activities, fishing, and use of natural hot springs. Rec-2 indicates recreational activities involving proximity to water, but generally with no body contact with water or any likelihood of ingestion of water. These include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, and aesthetic enjoyment associated with the above activities.

Source: Central Valley Water Board 2007b.

Hydrology

Flows in the Delta are difficult to measure because the tidal influence means that there is no meaningful relationship between stage and flow. The USGS, however, has been using acoustic doppler to measure flow at some locations. Appendix B, Table B-19 shows the minimum, mean, and maximum of the monthly average values for data measured between 1995 and 2004 in the San Joaquin River. Because most of these locations have tidal flow, flows usually move both downstream (positive flow) and upstream (negative flow) within a day. The *Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary* (SWRCB 1995) has standards for some of the biggest factors in Delta hydraulics: Delta outflow, Sacramento and San Joaquin River inflows, Delta exports, Delta Cross Channel gate position, and salinity gradients.

The downstream end of the San Joaquin River enters the southern end of the Delta-Carbona Watershed near its confluence with the Stanislaus River (Figure 3-24). It then flows north to the flow split at Old River, where there is sometimes a significant reduction in flow depending on the position of Delta barriers and the level of Delta exports. At Stockton, the San Joaquin River becomes known as the Deep Water Ship Channel (DWSC), which is dredged to allow passage of large cargo ships to the Port of Stockton. After passing through a web of Delta channels, the river terminates near the city of Antioch, where it merges with the Sacramento River.

In the past 20 years, average monthly flows at Vernalis have averaged about 1,000 cfs during summer (Table B-19 in Appendix B); flows have been as low as 400 cfs. The Vernalis flows are generally much less than the Sacramento River flows. Net flows near the downstream end of the San Joaquin River at Jersey Point are often similar to the flows at Vernalis, but a lot happens to the water between the two locations. Generally, more than half of the Vernalis flows go to the export pumps in the south Delta, and some of the Sacramento River flows contribute to flows in the central and south Delta via the Delta Cross Channel. Depending on flows in the San Joaquin River and the amount of exports, net flows at Jersey Point are sometimes negative.

Old River is basically a long, convoluted side channel of the San Joaquin River. The northern portion of Old River (starting at Vernalis to the southern portion of Old River), which flows east to west from the San Joaquin River to the DMC, has tidal flows; but, depending on flows and barriers, the net flow within this section of Old River can be very low (Jones & Stokes 2005a). North of the export pumps, Old River flows south to north from Clifton Court Forebay to Franks Tract and on to the San Joaquin River. Because of Delta exports, net flow in this section of river is often negative (i.e., in the upstream direction) (see Table B-19 in Appendix B).

Middle River starts near the upstream end of Old River. It then flows northwest, intersects many side channels, passes by flooded Mildred Island, and connects with the San Joaquin River. The southern portion of Middle River between Old River and Trapper Slough has relatively low flows because of its narrow, constricted channel. Farther north, Middle River carries significant flows—the flows often are toward the export pumps (see Table B-19 in Appendix B).

Marsh Creek originates on the eastern slopes of Mount Diablo. It merges with Dunn Creek, which carries mercury from the Mount Diablo Mine. Marsh Creek flows into a small reservoir, Marsh Creek Reservoir, and then discharges north into Big Break and the downstream end of the San Joaquin River near Jersey Point. Daily flows in the USGS database for September 2000–October 2004 for Marsh Creek near Brentwood ranged between 0.4 and 590 cfs, with an average of 8 cfs (Table B-19 in Appendix B).

Several side channels on the eastern edge of the Delta are included in this discussion. These are listed below in north to south order:

- Mosher Slough—Located at the northern edge of Stockton. It connects with Bear Creek at its downstream end and receives flow from Mosher Creek at its upstream end.
- Five Mile Slough—Originates in Stockton and extends to Fourteen Mile Slough.
- Turning Basin—The extension of the Stockton DWSC that is not part of the San Joaquin River. The Turning Basin allows ships to enter the Port of Stockton and provides room for turning around.
- Mormon Slough—Originates as a diversion from the Calaveras River at Bellota. It passes through Stockton and connects to the southern edge of the Turning Basin. Two sections of Mormon Slough have water quality issues. Commerce Street is located near the boundary between the Delta-Carbona Watershed and the North Valley Floor Watershed, and it is the dividing line for the two impaired sections of Mormon Slough. As a result, the downstream portion, from Commerce Street to the Turning Basin, is included in the Delta-Carbona Watershed, whereas the upstream portion is included in the North Valley Floor Watershed.
- Walker Slough—An eastern side channel to the Delta. Because it is predominantly outside of the Delta-Carbona Watershed, Walker Slough is included with its upstream watershed in the description of the North Valley Floor Watershed.

Water Quality

Water quality data from several studies and monitoring locations were evaluated to identify potential water quality issues in the Delta-Carbona Watershed (references are listed in Table 3-37). Data indicate that chlorpyrifos, diazinon, permethrin, and DDT are frequently present in concentrations that exceed water quality objectives (see Appendix C for water quality objectives).

The 2006 Section 303(d) list indicates that most areas of the Delta have elevated levels of chlorpyrifos and diazinon. During the past 10 years, however, the use of diazinon and chlorpyrifos in the Delta-Carbona Watershed has decreased substantially (Kratzer 2002). The concentration of these pesticides in the rivers also has decreased (Central Valley Water Board 2007b). See Table 3-37 for the potential sources of these contaminants.

The 2006 Section 303(d) list indicates that most of the Delta has elevated levels of DDT. There is a lack of data for DDT concentrations in the water column. DDT is a hydrophobic organochlorine pesticide that is extremely resilient in the environment and tends to bind to sediment. Thus DDT and its breakdown products, DDD and DDE, are typically found in the bed sediment of the river. DDT, DDD, and DDE are legacy pesticides that are no longer used.

In recent years, pyrethroids have been replacing some organophosphate use. Pyrethroids tend to bind with organic material and may be more likely to be present in sediment than in water (ESJWQC 2004). Total permethrin, permethrin-1, and permethrin-2 have been found in the Delta-Carbona Watershed in elevated concentrations (Central Valley Water Board 2007a). Table 3-37 describes the potential sources of these pesticides. Appendix C contains the water quality objectives used to identify the water quality concerns listed in the table.

Other pesticides that have been found in concentrations that exceed water quality objectives include disulfoton, dieldrin, carbofuran, methyl parathion, endrin, methomyl, esfenvalerate/fenvalerate, and linuron (Central Valley Water Board 2007a, Kratzer et al. 2002, Zamora et al. 2003, USGS 2005b). In addition to pesticides, naturally occurring metals can be mobilized and transported to surface water from irrigation return flows. Arsenic, boron, and nickel have been found in elevated concentrations in the Delta-Carbona Watershed (Central Valley Water Board 2007a, USGS 2005b).

Fluctuating levels of pH, along with elevated levels of EC and low levels of DO, have been observed in the Delta-Carbona Watershed. Factors contributing to fluctuating pH are still under investigation. Elevated levels of EC are associated with agricultural return flows or seawater intrusion. Low DO has been associated with nutrients from agricultural return flows (Central Valley Water Board 2007a).

TIEs were performed to attempt to identify the cause(s) of significant toxicity observed in water column and sediment test species. TIEs generally were performed on water samples that exceeded 50 percent mortality. Toxicity resulted on the minnow, water flea, and algae species. The results indicated that non-polar organics such as organophosphate insecticides (e.g., chlorpyrifos, diazinon, and parathion methyl) are linked to the toxicity problem in the Delta-Carbona Watershed (see Table 3-37) (Central Valley Water Board 2007a). In addition, an independent study found that bifenthrin and lambda-cyhalothrin are associated with much of the observed sediment toxicity (Weston et al. In Press).

Table 3-37. Known Agricultural Contaminants and Conditions That Affect Water Quality in the Delta-Carbona Watershed

Parameter	Potential Agricultural Sources/ Contribution to Water Quality Impairment	Sources
Chlorpyrifos	Pesticide used to protect agricultural crops	1, 2, 3, 4
Diazinon	Pesticide used to protect agricultural crops	1, 2, 3, 4
Disulfoton	Pesticide used to protect agricultural crops	1
Dieldrin	Pesticide used to protect agricultural crops	1, 4
Carbofuran	Pesticide used to protect agricultural crops	1
Methyl parathion	Pesticide used to protect agricultural crops	1
Endrin	Pesticide used to protect agricultural crops	1
Methomyl	Pesticide used to protect agricultural crops	1
Dimethoate	Pesticide used to protect agricultural crops	1
Esfenvalerate/fenvalerate, total	Pesticide used to protect agricultural crops	1
Linuron	Pesticide used to protect agricultural crops	1
Permethrin, total	Pesticide used to protect agricultural crops	1
Permethrin-1	Pesticide used to protect agricultural crops	1
Permethrin-2	Pesticide used to protect agricultural crops	1
Cyhalthrin, lambodia, total	Pesticide used to protect agricultural crops	1
DDT	Legacy pesticide potentially mobilized by irrigated agricultural operations	1
DDD	Legacy pesticide potentially mobilized by irrigated agricultural operations	1
DDE	Legacy pesticide potentially mobilized by irrigated agricultural operations	1
PCBs	Generally a result of commercial use	4

Parameter	Potential Agricultural Sources/ Contribution to Water Quality Impairment	Sources
Arsenic	Naturally occurring metal that is partly mobilized and concentrated by irrigated agriculture, causing toxic levels in receiving waters	1
Boron	Naturally occurring metal that is partly mobilized and concentrated by irrigated agriculture, causing toxic levels in receiving waters	4
Nickel	Naturally occurring metal that is partly mobilized and concentrated by irrigated agriculture, causing toxic levels in receiving waters	1
Bacteria	Likely a result of animal confinement facilities land application of waste	1
DO	Factors contributing to low DO are under investigation. Nutrient loads from irrigated lands may be connected to low DO.	1
EC	Factors contributing to high EC may involve elevated levels of salt on irrigated land.	1
pH	Factors contributing to high pH are under investigation.	1
Toxicity (minnow, flea, algae, sediment)	Toxicity identification evaluations (TIEs) strongly point to organophosphate insecticides (e.g., chlorpyrifos and diazinon) as the cause of such toxicity in the water column. Ammonia also was connected to toxicity in this watershed. TIEs strongly point to organochlorine pesticides and pyrethroids as the cause of such toxicity in the sediment. TIEs also indicate that bifenthrin and lambda-cyhalothrin are associated with much of the observed sediment toxicity in the Delta-Carbona Watershed.	1, 5

Sources:

[1] Central Valley Water Board 2007a.

[2] Kratzer et al. 2002.

[3] Zamora et al. 2003.

[4] USGS 2005b.

[5] Weston et al. In Press.

Note: Water bodies that are impacted from one or more of the contaminants listed in this table include Sand Creek, Marsh Creek, Kellogg Creek, Drain to South Canal, Drain to North Canal, Grantline Canal, Tom Paine Slough, Drain to Grantline Canal, Drain to Wing Levee Road, Unnamed Canal at Howard Road, Mid Roberts Drain, Return Irrigation Drain at MCD Road, Roberts Island Drain, Five Mile Slough, Mosher Slough, and the San Joaquin River source water canal at Holt and Nueger Roads.

II.F Ahwahnee Watershed

General Description

The Ahwahnee Watershed is located on the east side in the middle of the Central Valley (Figure 3-2). The Ahwahnee Watershed covers approximately 412,119 acres (644 square miles) from the headwaters of the Chowchilla and Fresno Rivers in the Sierra Nevada to the edge of the valley floor. The watershed extends downstream to and includes both Hensley Lake and Eastman Lake. The San Joaquin Valley Floor Watershed is located to the west, San Joaquin River Watershed to the south and southeast, Merced River Watershed to the north and northeast, and Mariposa Watershed to the northwest. (Figure 3-25.)

The climate of the Ahwahnee watershed is highly variable because of the broad range in elevation. Elevations range from 315 to 13,920 feet, the highest elevation in the larger San Joaquin River Basin. (USGS 2005a) At the lower elevations, the climate is arid to semi-arid with dry, hot summers and mild winters. Summer temperatures may be higher than 100°F, and winter temperatures are only occasionally below freezing. Conditions are cooler and there is more precipitation at the higher elevations. The winter snowpack, which accumulates above 5,000 feet elevation, supplies much of the water in this watershed.

Land Use Patterns

Native vegetation is the dominant land use in the Ahwahnee Watershed (Figure 3-37). Urban land use represents a relatively small proportion of the watershed. The combined acreage of urban, urban landscape, commercial, and residential designations totals less than 5 percent of the total acreage. Agriculture comprises less than 1 percent of the land use in the watershed. Much of this land could be non-irrigated, as it consists mainly of pasture and semi agricultural land, and pastureland may or may not be irrigated. Table 3-38 presents the land use acreages in the watershed.

Table 3-38. Land Use Acreage according to DWR and FRAP Land Use Data for the Ahwahnee Watershed

Land Use	Acreage	Percent Total
DWR Land Use Type		
Agriculture		
Deciduous Fruits and Nuts	54	0.0
Pasture	644	0.2
Semi agricultural and Incidental	113	0.0
Vineyards	103	0.0
Subtotal	914	0.2
Urban		
Urban Landscape	9	0.0
Urban Residential	9,047	2.2
Commercial	29	0.0
Subtotal	9,085	2.2

Land Use	Acreage	Percent Total
Native		
Native Vegetation	221,091	53.6
Riparian Vegetation	0	0.0
Water Surface	2,181	0.5
Subtotal	223,272	54.2
FRAP Land Use Type		
Agriculture	143	0.0
Barren/Other	13	0.0
Conifer	21,816	5.3
Hardwood	101,767	24.7
Herbaceous	29,494	7.2
Shrub	16,612	4.0
Urban	8,681	2.1
Water	312	0.1
Wetland	7	0.0
Subtotal	178,845	43.4
Total	**412,119**	**100.0**

Basin Plan Status

The Sacramento and San Joaquin Rivers Basin Plan (Central Valley Water Board 2007b) describes beneficial uses for waters in the Ahwahnee Watershed. Table 3-39 lists the beneficial uses of the Chowchilla River from its source to, and including, Eastman Lake and the Fresno River from its source to Hensley Lake.

Table 3-39. Beneficial Uses in the Ahwahnee Watershed

Beneficial Uses	Fresno River, source to Hensley Lake	Chowchilla River, source to Eastman Lake
Municipal & Domestic	E	E
Irrigation	E	E
Stock Watering	E	E
Process		
Service Supply		
Power		
Rec-1*	E	E
Rec-2*	E	E
Freshwater Habitat—Warm	E	E
Freshwater Habitat—Cold	E	E
Migration—Warm		

Beneficial Uses	Fresno River, source to Hensley Lake	Chowchilla River, source to Eastman Lake
Migration—Cold		
Spawning—Warm		
Spawning—Cold		
Wildlife Habitat	E	E
Navigation		

P = Potential, E = Existing.

* Rec-1 indicates recreational activities involving body contact with water, where ingestion of the water is reasonably possible. These uses include, but are not limited to, swimming, wading, water skiing, skin and scuba diving, surfing, white water activities, fishing, and use of natural hot springs. Rec-2 indicates recreational activities involving proximity to water, but generally with no body contact with water or any likelihood of ingestion of water. These include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, and aesthetic enjoyment associated with the above activities.

Source: Central Valley Water Board 2007b.

Hydrology

In its upper watershed, the Chowchilla River has a West Fork, Middle Fork, and East Fork. The upper watershed is located in both Mariposa and Madera Counties (Figure 3-25). The East Fork tributary extends the farthest into the Sierra Nevada. It originates near the Chowchilla Mountains, which are less than 7,000 feet elevation. The downstream end of the Upper Chowchilla River extends to the intersection of Merced County, Mariposa County, and Madera County in the northwest corner of the watershed, about 6 miles downstream of Buchanan Dam.

Eastman Lake, formed by Buchanan Dam, is the only large reservoir in the Chowchilla River Watershed. It has a capacity of 150,000 acre-feet, and its watershed area is 235 square miles. At an elevation of 600 feet, summers are warm and winters mild. Eastman Lake is used for flood control, irrigation, and recreation. The only currently operated flow gauging station along the Chowchilla River is the CDEC station at Eastman Lake. Releases from the lake are typically less than 200 cfs. Inflow to the lake varies seasonally, with high flows in winter and spring and low flows in summer and fall. Table B-16 in Appendix B contains the monthly minimum, mean, and max flows for the inflow to the lake; these range from 0 to 7,000 cfs.

The Fresno River is located in Madera County (Figure 3-25). Hensley Lake, formed by Hidden Dam, is the only large reservoir in the Fresno River Watershed. It is operated by the Corps and has a capacity of 90,000 acre-feet. The watershed area of the lake is approximately 258 square miles. Hensley Lake is used for flood control, irrigation, resource management, and recreation. The Madera ID obtains some of its water from the Fresno River. The only currently operated flow gauging station along the Fresno River is the CDEC station at Hensley Lake. Flow measurements for inflow to Hensley Lake indicate high flows in late winter and low flows during summer to fall. Table B-17 in Appendix B contains the flow data on Hensley Lake. Average monthly flows range from 0 to 1,400 cfs. See the Valley Floor Watershed section for downstream information.

Water Quality

There are few, if any water quality concerns in the Upper Fresno River and Chowchilla River. No 2006 Section 303(d)-listed pollutants are associated with these rivers or their tributaries, and there are no known water quality problems in this upper watershed. This is likely due to the dominance of native vegetation and low occurrence of urban, industrial, irrigated agriculture, or other developed land uses in this watershed.

II.G Mariposa Watershed

General Description

The Mariposa Watershed is located on the eastern side of the Central Valley just south of the Merced River Watershed. (Figure 3-2). The Mariposa Watershed is bordered by the Merced River Watershed to the north, Ahwahnee Watershed to the east and southeast, and the San Joaquin Valley Floor Watershed to the west (Figure 3-26). The Mariposa Watershed includes 209,002 acres (327 square miles) from the headwaters of Bear Creek to the edges of the valley floor.

The climate varies with elevation, which ranges from 308 to 4,252 feet. At the lower elevations, the climate is arid to semi-arid with dry, hot summers and mild winters. Summer temperatures may be higher than 100°F, and winter temperatures are only occasionally below freezing. Conditions are cooler and there is more precipitation at the higher elevations. The major water bodies in the watershed are Bear Creek, Owens Creek, and Upper Mariposa Creek.

Land Use Patterns

Native vegetation makes up almost the entire land use (approximately 98 percent) in the watershed (Figure 3-38). Urban land uses account for less than 2 percent, and irrigated agriculture occupies less than 1 percent of the land use in the watershed. Table 3-40 includes land use acreage according to DWR land use data for the Mariposa Watershed.

Basin Plan Status

The Sacramento and San Joaquin Rivers Basin Plan (Central Valley Water Board 2007b) describes beneficial uses for waters in the Mariposa Watershed. The beneficial uses of Bear, Owens, and Upper Mariposa Creeks are designated through the tributary rule. As such, the beneficial uses for these creeks are the same as for the San Joaquin River between Sack Dam and the Mouth of the Merced River. Table 3-33 contains the beneficial uses of the San Joaquin River between Sack Dam and the Mouth of the Merced River.

Hydrology

Bear Creek originates much lower in the Sierra Nevada than the Stanislaus, Tuolumne, or Merced Rivers (Figure 3-26). It starts in Mariposa County near the town of Bear Valley, which is at 2,050 feet elevation. Just before entering Merced County, Bear Creek flows through Bear Reservoir, a small reservoir operated by the Corps.

USGS does not have any active gauges on Bear Creek. However, CDEC has a flow gauge in the watershed at Bear Reservoir. Average monthly flows range from 0 cfs during some summer months to almost 450 cfs during winter (Table B-21 in Appendix B).

Owens Creek flows out of the Guadalupe Mountains, a small range west of the Sierra Nevada, into Owens Reservoir, eventually reaching the valley floor. Owens Creek flows into Owens Reservoir are low year-round, but the lowest flows are from July through November (0 cfs). The highest flows occur from January through March (110 cfs; Table B-21 in Appendix B).

Table 3-40. Land Use Acreage according to DWR Land Use Data for the Mariposa Watershed

DWR Land Use Type	Acres	Percent Total
Agriculture		
Citrus and Subtropical	9	0.0
Grain and Hay	15	0.0
Pasture	256	0.1
Semi agricultural and Incidental	202	0.1
Vineyards	53	0.0
Subtotal	535	0.3
Urban		
Urban—Unclassified	948	0.5
Urban Landscape	20	0.0
Urban Residential	2,797	1.3
Commercial	88	0.0
Industrial	117	0.1
Entry Denied	91	0.0
Vacant	25	0.0
Subtotal	4,086	2.0
Native		
Native Vegetation	204,175	97.7
Water Surface	206	0.1
Subtotal	204,381	97.8
Total	**209,002**	**100.0**

Although this watershed is outside the Central Valley, there are no FRAP land use data for the Mariposa Watershed.

Upper Mariposa Creek flows south through the western Sierra Nevada, then heads southwest as it flows out of the mountains into Mariposa Reservoir. Tributaries to Upper Mariposa Creek include Agua Fria Creek and Ganns Creek. Flows into Mariposa Reservoir are intermittent, with little to no flow (0 cfs) from July through October. The highest flows occur from December through March (815 cfs; Table B-21 in Appendix B).

Water Quality

There are few, if any, water quality concerns in the Mariposa Watershed. No 2006 Section 303(d)-listed pollutants are associated with Bear, Upper Mariposa, or Owens Creeks; and there are no known water quality problems in this watershed. This is likely due to the dominance of native vegetation and low occurrence of urban, industrial, irrigated agriculture, or other developed land uses in this watershed.

II.H Upper Mokelumne River–Upper Calaveras River Watershed

General Description

The Upper Mokelumne River–Upper Calaveras River Watershed (MRCR Watershed) is located on the eastern side of the Central Valley, just east of Lodi and Stockton. The MRCR Watershed is bordered to the north by the Sacramento–Amador and El Dorado Watersheds and to the south by the Tuolumne River Watershed (Figure 3-2). To the west is the North Valley Floor Watershed and to the east are Alpine County and the Sierra Nevada. The watershed is approximately 626,776 acres (979 square miles) (DWR 2005c) (Figure 3-27). The topography ranges broadly in this watershed. The minimum elevation is 203 feet, the mean elevation is 3,839 feet, and the maximum elevation is 10,371 feet (USGS 2005a). The major water features in the watershed are the Upper Calaveras River and the Upper Mokelumne River.

The climate of the MRCR Watershed is highly variable because of the large range in elevation. At the lower elevations, the climate is arid to semi-arid with dry, hot summers and mild winters. Summer temperatures may be higher than 100°F, and winter temperatures are only occasionally below freezing. Conditions are cooler and there is more precipitation at the higher elevations. The winter snowpack, which accumulates above 5,000 feet elevation, supplies much of the water in this watershed.

Land Use Patterns

Native vegetation is the primary land use type in the MRCR Watershed (Figure 3-39). Water surface accounts for slightly over 1 percent of the land use, and irrigated agriculture accounts for less than 1 percent of the land use in the watershed. Table 3-41 identifies land use acreage according to DWR and FRAP land use data for the MRCR Watershed.

Table 3-41. Land Use Acreage according to DWR and FRAP Land Use Data for the Upper Mokelumne River–Upper Calaveras River Watershed

Land Use	Acres	Percent Total
DWR Land Use Type		
Agriculture		
Pasture	1	0.0
Subtotal	1	0.0
Urban		
Urban—Unclassified	99	0.0
Urban Residential	1,418	0.2
Commercial	93	0.0
Industrial	25	0.0
Vacant	28	0.0
Subtotal	1,663	0.3

Land Use	Acres	Percent Total
Native		
Native Vegetation	200,038	31.8
Riparian Vegetation	401	0.1
Water Surface	3,696	0.6
Subtotal	204,135	32.4
FRAP Land Use Type		
Agriculture	37	0.0
Barren/Other	1,794	0.3
Conifer	213,165	33.8
Hardwood	91,531	14.5
Herbaceous	54,051	8.6
Shrub	55,265	8.8
Urban	2,263	0.4
Water	5,585	0.9
Wetland	286	0.0
Subtotal	423,977	67.3
Total	**629,776**	**100**

Basin Plan Status

The Sacramento and San Joaquin Rivers Basin Plan (Central Valley Water Board 2007b) describes beneficial uses for waters in the MRCR Watershed. Table 3-42 lists the beneficial uses of the Mokelumne River from its source to Pardee Reservoir and the Calaveras River from its source to New Hogan Reservoir.

Table 3-42. Beneficial Uses in the Upper Mokelumne River–Upper Calaveras River Watershed

Beneficial Use	Upper Mokelumne River	Upper Calaveras River
Municipal & Domestic	E	
Irrigation		
Stock Watering		
Process		
Service Supply		
Power	E	
Rec-1*	E	E
Rec-2*	E	E
Freshwater Habitat—Warm	E	E
Freshwater Habitat—Cold	E	E
Migration—Warm	E	E
Migration—Cold		

Beneficial Use	Upper Mokelumne River	Upper Calaveras River
Spawning—Warm	E	E
Spawning—Cold	E	E
Wildlife Habitat	E	E
Navigation		

E = Existing.

* Rec-1 indicates recreational activities involving body contact with water, where ingestion of the water is reasonably possible. These uses include, but are not limited to, swimming, wading, water skiing, skin and scuba diving, surfing, white water activities, fishing, and use of natural hot springs. Rec-2 indicates recreational activities involving proximity to water, but generally with no body contact with water or any likelihood of ingestion of water. These include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, and aesthetic enjoyment associated with the above activities.

Source: Central Valley Water Board 2007b.

Hydrology

The Upper Calaveras River drains east to west in Calaveras County (Figure 3-27). The Upper Calaveras River flows into New Hogan Reservoir (which is operated by the Corps), drains out of the base of the reservoir, and meanders westward by the city of Stockton and toward the Delta. However, this analysis covers only the part of the Calaveras River that flows into New Hogan Reservoir. The outflow from the reservoir is located in the North Valley Floor Watershed and is discussed further in that section. The storage capacity of New Hogan Reservoir is 317,100 acre-feet (DWR 2005d). Monthly average flow for the Calaveras River ranges from as little as 1 cfs during the dry season to as much as 2,800 cfs during the storm season, as shown in Table B-22 in Appendix B.

The portions of the Upper Mokelumne River in this watershed are the inflow into Pardee Reservoir, the outflow to Pardee Reservoir, and the inflow to Comanche Reservoir just north of the Upper Calaveras River (Figure 3-27). The Mokelumne River outflow from Comanche Reservoir is described in the North Valley Floor Watershed. The Upper Mokelumne River follows the border between Amador and Calaveras Counties. Above Pardee Reservoir, the Mokelumne River is divided between the North Fork, the Middle Fork, and the South Fork. The South Fork is unregulated and drains into the Middle Fork; however, the North Fork and Middle Fork contain diversions and dams. The main tributaries to the North Fork Mokelumne River are Blue Creek to Deer Creek, and Bear Creek. The main reservoir on the North Fork Mokelumne River is Salt Springs Reservoir, which has a storage capacity of 141,900 acre-feet. The tributary to the Middle Fork is Forest Creek. The Middle Fork has two reservoirs above Pardee—the Middle Fork Reservoir and the Jeff Davis Reservoir. The Middle Fork Reservoir has a storage capacity of 1,740 acre-feet, and the Jeff Davis Reservoir has a storage capacity of 1,750 acre-feet. Prior to reaching Pardee Reservoir, all three forks of the Mokelumne River converge to form one inflow to the reservoir, which has a storage capacity of 197,550 acre-feet (DWR 2005d). Monthly average flow for the Mokelumne River ranges from 300 cfs during the dry season to 5,600 cfs during the storm season and is presented in Table B-22 in Appendix B.

Water Quality

Few, if any water quality concerns have been identified in the Upper Mokelumne River and Upper Calaveras River. No 2006 Section 303(d)-listed pollutants are associated with the Upper Mokelumne River or Upper Calaveras River. This is likely due to the dominance of native vegetation and low occurrence of urban, industrial, irrigated agriculture, or other developed land uses in this watershed. No known water quality problems are associated with these rivers.

II.I Merced River Watershed

General Description

The Merced River drains an approximately 816,640-acre (1,276-square mile) watershed on the western slope of the Sierra Nevada in the southern portion of California's Central Valley (Figure 3-2). Elevations in the basin range from 13,000 feet in Yosemite National Park to approximately 338 feet near Merced Falls (USGS 2005a). The Upper Merced River Watershed is bordered by the Tuolumne River Watershed to the north; the Mariposa, Fresno River, and San Joaquin River Watersheds to the south; the Valley Floor Watershed on the west; and the Tuolumne and San Joaquin River Watersheds on the east (Figure 3-28). Major water bodies include the Merced River and Lake McClure.

The climate of the Merced River Watershed is highly variable because of the large range in elevation. At the lower elevations around Lake McClure, the climate is arid to semi-arid with dry, hot summers and mild winters. Summer temperatures may be higher than 100°F, and winter temperatures are only occasionally below freezing. Conditions are cooler and there is more precipitation at the higher elevations. The winter snowpack, which accumulates above 5,000 feet elevation, supplies much of the water in this watershed.

Land Use Patterns

The primary land use in the upper Merced River Watershed is native vegetation, accounting for more than 90 percent of the watershed (Figure 3-40). Very little irrigated agriculture exists in the watershed, accounting for less than 1 percent of the total land use acres. Table 3-43 shows land use acreage according to DWR and FRAP land use data for the upper Merced River Watershed.

Table 3-43. Land Use Acreage according to DWR and FRAP Land Use Data for the Merced River Watershed

Land Use	Acres	Percent Total
DWR Land Use Type		
Agriculture		
Deciduous Fruits and Nuts	30	0.0
Pasture	2,471	0.4
Semi agricultural and Incidental	111	0.0
Vineyards	7	0.0
Subtotal	2,619	0.4
Urban		
Urban—Unclassified	250	0.0
Urban Landscape	392	0.1
Urban Residential	8,417	1.2
Commercial	194	0.0
Industrial	36	0.0
Subtotal	9,289	1.3

Land Use	Acres	Percent Total
Native		
Native Vegetation	583,543	83.0
Riparian Vegetation	344	0.0
Water Surface	6,254	0.9
Subtotal	590,141	83.9
FRAP Land Use Type		
Barren/Other	26,913	3.8
Conifer	68,026	9.7
Hardwood	877	0.1
Herbaceous	22	0.0
Shrub	2,809	0.4
Water	1,103	0.2
Wetland	1,488	0.2
Subtotal	101,238	14.4
Total	**703,287**	**100.0**

Basin Plan Status

The Sacramento and San Joaquin Rivers Basin Plan (Central Valley Water Board 2007b) describes beneficial uses for waters in the Merced River Watershed. Table 3-44 lists the beneficial uses of the Merced River upstream of McSwain Dam.

Table 3-44. Beneficial Uses in the Merced River Watershed

Beneficial Uses	Merced River (upstream of McSwain Dam)
Municipal & Domestic	P
Irrigation	E
Stock Watering	
Process	
Service Supply	
Power	E
Rec-1*	E
Rec-2*	E
Freshwater Habitat—Warm	E
Freshwater Habitat—Cold	E
Migration—Warm	
Migration—Cold	
Spawning—Warm	
Spawning—Cold	
Wildlife Habitat	E
Navigation	

P = Potential, E = Existing.

* Rec-1 indicates recreational activities involving body contact with water, where ingestion of the water is reasonably possible. These uses include, but are not limited to, swimming, wading, water skiing, skin and scuba diving, surfing, white water activities, fishing, and use of natural hot springs. Rec-2 indicates recreational activities involving proximity to water, but generally with no body contact with water or any likelihood of ingestion of water. These include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, and aesthetic enjoyment associated with the above activities.

Source: Central Valley Water Board 2007b.

Hydrology

The principal tributaries of the South Fork Merced River include Merced Peak Fork, Lyell Fork, Triple Peak Fork, and Red Peak Fork; and Echo, Sunrise, Illilouette, Tenaya, Yosemite, Bridalveil, Cascade, Grouse, Avalanche, Indian, and Crane Creeks (Figure 3-28). The Merced River descends 8,000 feet from its headwaters through glacially carved canyons along a 24-mile path. When it enters Yosemite Valley, the river flows in a shallow channel approximately 100–300 feet wide in most places. Leaving the valley, the river winds through the narrow, steep-sided Merced River gorge at a gradient of 70 feet per mile.

The South Fork Merced River flows westward from its headwaters at about 10,500 feet elevation down to 3,500 feet at its confluence with the Merced River. Tributaries of the South Fork include Chilnualna Creek, Big Creek, Alder Creek, and Bishop Creek (NPS 2005).

Exchequer Dam forms Lake McClure, the largest reservoir on the Merced River, with a capacity of 1,046,000 acre-feet and a watershed of approximately 1,037 square miles. Downstream of Lake McClure, McSwain Dam forms Lake McSwain. Monthly average flows of the Merced River range from approximately 1 to approximately 8,000 cfs. Table B-23 in Appendix B contains minimum, mean, and maximum flows recorded at the Merced River inflow into McClure Reservoir from 1995 to 2004.

The Merced River is listed as a Wild and Scenic River under the Wild and Scenic River Act, which is intended to protect designated rivers from degradation. The designated area begins at its source (including Red Peak Fork, Merced Peak Fork, Triple Peak Fork, and Lyle Fork) in Yosemite National Park and extends to a point 300 feet upstream of the confluence with Bear Creek. The South Fork designation begins at its source in Yosemite National Park and extends to the confluence with the mainstem.

Water Quality

There are few, if any water quality concerns in the upper Merced River Watershed. No Section 303(d)-listed pollutants are associated with the upper Merced River or its tributaries. This is likely due to the dominance of native vegetation and low occurrence of urban, industrial, irrigated agriculture, or other developed land uses in this watershed. However, it is important to note that downstream Merced River water quality is impaired for three pollutants. See the San Joaquin Valley Floor Watershed for more information.

II.J North Valley Floor Watershed

General Description

The North Valley Floor Watershed (NVF Watershed) is located east of the Delta in the Central Valley and covers approximately 571,000 acres (892 square miles) from the Sierra Nevada foothills to the eastern edge of the Delta (Figure 3-2). The NVF Watershed lies mostly within San Joaquin County, although the eastern edge extends (from north to south) into Amador, Calaveras, and Stanislaus Counties (Figure 3-29). The elevation in this watershed ranges from -3 to 2,582 feet.

The climate of the NVF Watershed is arid to semi-arid with dry, hot summers and mild winters. Summer temperatures may be higher than 100°F, and winter temperatures are only occasionally below freezing. The weather conditions are somewhat more moderate than the rest of the Central Valley because of the effect of ocean air on the weather in the Delta. The winter snowpack in the Sierra Nevada, which accumulates above 5,000 feet elevation (outside of this watershed), supplies much of the water in the basin. Some small drainages, however, do not extend into the mountains.

The Mokelumne River and Calaveras River are the two largest watersheds in the NVF Watershed. Comanche Reservoir and Pardee Reservoir are located on the Mokelumne River, and New Hogan Reservoir is located on the Calaveras River. Additional details about the larger waterways in the NVF Watershed are provided in the hydrology section below.

Land Use Patterns

Irrigated agriculture accounts for more than one-third of the land use in the NVF Watershed (Figure 3-41). Urban land use accounts for slightly more than 5 percent of the land use. Table 3-45 contains land use acreage according to DWR and FRAP land use data for the NVF watershed.

Table 3-45. Land Use Acreage according to DWR and FRAP Land Use Data for the North Valley Floor Watershed

Land Use	Acres	Percent Total
DWR Land Use Types		
Agriculture		
Citrus and Subtropical	58	0.0
Deciduous Fruits and Nuts	51,692	9.1
Field Crops	22,371	3.9
Grain and Hay	31,120	5.5
Idle	6,233	1.1
Pasture	32,557	5.7
Rice	2,963	0.5
Semi agricultural and Incidental	4,466	0.8
Truck, Nursery, and Berry Crops	22,301	3.9
Vineyards	61,895	10.8
Subtotal	235,656	41.3

Land Use	Acres	Percent Total
Urban		
Urban—Unclassified	27,258	4.8
Urban Landscape	1,689	0.3
Urban Residential	3,559	0.6
Commercial	734	0.1
Industrial	2,825	0.5
Vacant	3,922	0.7
Subtotal	39,987	7.0
Native		
Native Vegetation	167,613	29.4
Barren and Wasteland	11	0.0
Riparian Vegetation	966	0.2
Water Surface	7,055	1.2
Subtotal	175,645	30.8
FRAP Land Use Types		
Agriculture	762	0.1
Barren/Other	280	0.0
Conifer	7,975	1.4
Hardwood	34,460	6.0
Herbaceous	70,008	12.3
Shrub	2,157	0.4
Urban	274	0.0
Water	3,793	0.7
Subtotal	119,709	21.0
Total	**570,998**	**100**

Basin Plan Status

The Sacramento and San Joaquin Rivers Basin Plan (Central Valley Water Board 2007b) describes beneficial uses for waters in the NVF Watershed. Table 3-46 lists the beneficial uses of Comanche Reservoir, the lower Mokelumne River (from Camanche Dam to the Delta), and the Calaveras River from New Hogan Reservoir to the Delta.

Table 3-46. Beneficial Uses in the North Valley Floor Watershed

Beneficial Uses	Comanche Reservoir	Lower Mokelumne River	Lower Calaveras River
Municipal & Domestic	E		E
Irrigation	E	E	E
Stock Watering	E	E	E
Process			P
Service Supply			P

Beneficial Uses	Comanche Reservoir	Lower Mokelumne River	Lower Calaveras River
Power			
Rec-1*	E	E	E
Rec-2*	E	E	E
Freshwater Habitat—Warm	E	E	E
Freshwater Habitat—Cold	E	E	E
Migration—Warm	E	E	E
Migration—Cold		E	E
Spawning—Warm	E	E	E
Spawning—Cold	E	E	E
Wildlife Habitat	E	E	E
Navigation			

P = Potential, E = Existing.

* Rec-1 indicates recreational activities involving body contact with water, where ingestion of the water is reasonably possible. These uses include, but are not limited to, swimming, wading, water skiing, skin and scuba diving, surfing, white water activities, fishing, and use of natural hot springs. Rec-2 indicates recreational activities involving proximity to water, but generally with no body contact with water or any likelihood of ingestion of water. These include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, and aesthetic enjoyment associated with the above activities.

Source: Central Valley Water Board 2007b.

Hydrology

The Mokelumne River is the largest river in the NVF Watershed. The lower Mokelumne River extends 28 miles from Camanche Dam to the Delta. The portion of the river in the NVF Watershed includes Comanche Reservoir and extends close to the Delta, approximately 7 miles upstream of the confluence with the Cosumnes River (Figure 3-29). Comanche Reservoir is the largest reservoir in the Mokelumne River watershed, with a capacity of 430,800 acre-feet. The East Bay Municipal Utility District (EBMUD) owns and operates the Comanche Reservoir, as well as Pardee Reservoir, which is upstream of Comanche Reservoir. EBMUD withdraws water from Comanche Reservoir and Pardee Reservoir via pipelines. Minimum instream flows are required below Comanche Reservoir to protect downstream beneficial uses in the Mokelumne River.

Monthly average releases from Comanche Reservoir vary between approximately 150 and 5,000 cfs (Table B-24 in Appendix B). Average releases are approximately 1,000 cfs during winter and spring and taper to approximately 300 cfs during fall. Flows downstream at Woodbridge (just northwest of the City of Lodi) are considerably lower, partly because of the diversions to the Woodbridge Canal at Lodi Lake.

New Hogan Reservoir, which is upstream of the NVF Watershed and has a capacity of 317,100 acre-feet, is the largest reservoir in the Calaveras River watershed and is operated by the Corps. The Calaveras River runs east to west through the middle of the NVF Watershed. The portion of the Calaveras River in the NVF Watershed extends from Jenny Lind Road (about 7 miles downstream of New Hogan Reservoir) to the Delta near Stockton. The monthly average releases from New Hogan Reservoir vary from approximately 10 to 3,100 cfs, with average flows from spring through fall staying at approximately 100–200 cfs (Table B-22 in Appendix B).

Mormon and Walker Sloughs are small tributaries to the Delta. They have similar water quality problems that are associated with their proximity to the Stockton urban area.

Mormon Slough originates as a diversion from the Calaveras River at Bellota. It passes through Stockton and connects to the southern edge of the Turning Basin. Two sections of Mormon Slough have water quality issues. Commerce Street is located near the boundary between the Delta-Carbona Watershed and NVF Watershed, and it is the dividing line for the two impaired sections of Mormon Slough. The downstream portion, from Commerce Street to the Turning Basin, is included in the Delta-Carbona Watershed, and the upstream portion is included in the NVF Watershed.

Walker Slough is predominantly in the NVF Watershed although it extends into the Delta-Carbona Watershed. Walker Slough is a small section of channel about 2 miles long that is connected to Duck Creek at its upstream end and French Camp Slough at its downstream end. It is located south of Mormon Slough near the southern edge of Stockton.

Little Johns Creek is a small drainage that connects to French Camp Slough and the Delta. Little Johns Creek is not considered to have significant water quality problems, but some of its tributaries have water quality issues that are associated with their proximity to dairies. These small tributaries are:

- Lone Tree Creek—Lone Tree Creek runs along the southern edge of the NVF Watershed, with some small sections falling in the San Joaquin Valley Floor Watershed. Lone Tree Creek is a direct tributary to Little Johns Creek
- Temple Creek—Temple Creek is north of Lone Tree Creek and is a small tributary to Lone Tree Creek.
- Avena Drain—Avena Drain is also a tributary to Lone Tree Creek and is located between Lone Tree Creek and Temple Creek. Its main source of inflow is agricultural drainage and storm runoff.

Water Quality

Water quality data from several studies and monitoring locations were evaluated to identify potential water quality issues in the NVF Watershed (references are listed in Table 3-47). Data indicate that chlorpyrifos, diazinon, permethrin, and DDT are frequently present in one or more water bodies in concentrations that exceed water quality objectives (see Appendix C for water quality objectives).

The 2006 Section 303(d) list indicates that most of the Delta has elevated levels of chlorpyrifos and diazinon. During the past 10 years, however, the use of diazinon and chlorpyrifos in the NVF Watershed has decreased substantially (Kratzer 2002). The concentration of these pesticides in the rivers also has decreased (Central Valley Water Board 2004a). See Table 3-47 for the potential sources of these contaminants.

The Smith Canal, which is located in the urbanized environment of the City of Stockton and drains into the San Joaquin River, receives the majority of urban runoff from the City of Stockton. The Smith Canal is listed as being impaired for organophosphate pesticides, low DO, and pathogens. Because the impairments are a result of urban runoff and not irrigated agriculture, the Smith Canal is not included in Table 3-47.

The 2006 Section 303(d) list indicates that most of the Delta has elevated levels of DDT. There is a lack of data for DDT concentrations in the water column. DDT is a hydrophobic organochlorine pesticide that is extremely resilient in the environment and tends to bind to sediment. Thus DDT and its breakdown products, DDD and DDE, are typically found in the bed sediment of the river. DDT, DDD, and DDE are legacy pesticides that are no longer used. Data indicate that DDT, DDD, and DDE are still present in the NVF Watershed (Central Valley Water Board 2007a).

Table 3-47. Known Agricultural Contaminants and Conditions That Affect Water Quality in the North Valley Floor Watershed

Parameter	Potential Agricultural Sources/ Contribution to Water Quality Impairment	Sources
Chlorpyrifos	Pesticide used to protect agricultural crops	1, 2, 3, 4
Diazinon	Pesticide used to protect agricultural crops	1, 2, 3, 4
Diuron	Pesticide used to protect agricultural crops	1
Dieldrin	Pesticide used to protect agricultural crops	1
Carbofuran	Pesticide used to protect agricultural crops	1
Methyl parathion	Pesticide used to protect agricultural crops	1
Azinphos-methyl	Pesticide used to protect agricultural crops	1
Dimethoate	Pesticide used to protect agricultural crops	1
Cypermethrin, total	Pesticide used to protect agricultural crops	1
Permethrin-1	Pesticide used to protect agricultural crops	1
Permethrin-2	Pesticide used to protect agricultural crops	1
Cyhalthrin, lambodia, total	Pesticide used to protect agricultural crops	1
DDT	Legacy pesticide potentially mobilized by irrigated agricultural operations	1
DDD	Legacy pesticide potentially mobilized by irrigated agricultural operations	1
DDE	Legacy pesticide potentially mobilized by irrigated agricultural operations	1
Copper	Naturally occurring metal that is used as a pesticide	
Arsenic	Naturally occurring metal that is partly mobilized and concentrated by irrigated agriculture, causing toxic levels in receiving waters	1
Boron	Naturally occurring metal that is partly mobilized and concentrated by irrigated agriculture, causing toxic levels in receiving waters	4
Nickel	Naturally occurring metal that is partly mobilized and concentrated by irrigated agriculture, causing toxic levels in receiving waters	1
Bacteria	Likely a result of animal confinement facilities land application of waste	1
DO	Factors contributing to low DO are under investigation. Nutrient loads from irrigated lands may be connected to low DO.	1
EC	Factors contributing to high EC may involve elevated levels of salt on irrigated land.	1
pH	Factors contributing to high pH are under investigation.	1

Parameter	Potential Agricultural Sources/ Contribution to Water Quality Impairment	Sources
Toxicity (minnow, flea, algae, sediment)	Toxicity identification evaluations (TIEs) strongly point to organophosphate insecticides (e.g., chlorpyrifos and diazinon) as the cause of much of the observed water toxicity. TIEs also indicate that bifenthrin and lambda-cyhalothrin are associated with much of the observed sediment toxicity in the North Valley Floor Watershed.	1, 5

Sources:

[1] Central Valley Water Board 2007a.
[2] Kratzer et al. 2002.
[3] Zamora et al. 2003.
[4] USGS 2005b.
[5] Weston et al. In Press.

Note: Water bodies that are impacted from one or more of the contaminants listed in this table include Bear Creek at Alpine Road, Calaveras River at Pezzi Road, Delta Drain—Terminous Tract off Glascock Road, Delta Drain—Terminous Tract off Guard Road, Drain to Brack Drive at Woodbridge Road, Duck Creek at Highway 4, French Camp Slough at Airport Way, Little John Creek at Newcastle Road, Little John Creek at Jack Tone Road, Lone Tree Creek at Bernnan Road, Lone Tree Creek at Jack Tone Road, Lone Tree Creek at Newcastle Road, Mokelumne River at Bruella Road, Mormon Slough at Jack Tone Road, Pixley Slough at Eightmile Road, Potato Slough at Highway 12, Drain 12 at French Camp Road, Drain 14 at Lone Tree Creek, Drain to Pixley Slough at Davis Road, Pixley Slough at Ham Lane, Sweet Lateral, Unnamed Slough to Lone Tree Creek at Jack Tone Road, and Unnamed Slough at Wildwood Road.

In recent years, pyrethroids have replaced some organophosphate use. Pyrethroids tend to bind with organic material and may be more likely to be present in sediment than in water (ESJWQC 2004). Total cypermethrin, cyhalthrin, permethrin-1, and permethrin-2 have been found in the NVF Watershed in elevated concentrations (Central Valley Water Board 2007a). Table 3-47 describes the potential sources of these pesticides.

Other pesticides that are used to protect agricultural crops but have been found to be problematic to water quality include azinphos-methyl, dieldrin, carbofuran, methyl parathion, dimethoate, and diuron (Central Valley Water Board 2007a, Kratzer, et al. 2002b, Zamora et al. 2003, USGS 2005b). Copper, a naturally occurring metal that is used as a pesticide, has been found in elevated concentrations in the NVF Watershed. In addition to pesticides, naturally occurring metals can be mobilized and transported to surface water from irrigation return flows. Arsenic, boron, and nickel have been found in elevated concentrations in the NFV Watershed (Central Valley Water Board 2007a, USGS 2005b).

Fluctuating levels of pH along with elevated levels of EC and low levels of DO have been found in the NFV Watershed. Factors contributing to fluctuating pH are still under investigation. Elevated levels of EC can be associated with agricultural return flows. Low DO has been associated with nutrients from agricultural return flows (Central Valley Water Board 2007a).

Toxicity tests and TIEs were performed for ILRP monitoring in an attempt to identify the causes of water toxicity in the test organisms. TIEs generally were performed on the water samples that exceeded 50 percent mortality. Toxicity was found to affect algae growth, the water flea, and the fathead minnow. The results indicated that non-polar organics such as organophosphate insecticides (e.g., chlorpyrifos, diazinon, and parathion methyl) are causing the toxicity problem in the NVF Watershed (see Table 3-47) (Central Valley Water Board 2007a). In addition, an independent study found that bifenthrin and Lambda-cyhalothrin are associated with much of the observed sediment toxicity (Weston et al. In Press).

II.K Stanislaus River Watershed

General Description

The Stanislaus River Watershed is located on the eastern side of the Central Valley, just east of the City of Ripon (Figure 3-2). The upper Stanislaus River forms the northern boundary of Stanislaus and Tuolumne Counties and flows near the cities of Ripon, Riverbank, and Oakdale. It drains an area of about 638,080 acres (997 square miles) from its source to Knights Ferry. Elevations range from 180 to 11,365 feet (USGS 2005a) (Figure 3-30). The upper Stanislaus River is the major water body in the watershed; many small drainages supply flow to the river.

The climate of the Stanislaus River Watershed is highly variable because of the wide range in elevation. At the lower elevations, the climate is arid to semi-arid with dry, hot summers and mild winters. Summer temperatures may be higher than 100°F, and winter temperatures are only occasionally below freezing. Conditions are cooler and there is more precipitation at the higher elevations. The winter snowpack, which accumulates above 5,000 feet elevation, supplies much of the water in this watershed.

Land Use Patterns

Native vegetation is the primary land use in the upper Stanislaus River Watershed (Figure 3-42). Water accounts for almost 3 percent of the land use. Very little irrigated agriculture is located in this watershed. Table 3-48 lists land use acreage according to DWR and FRAP land use data for the upper Stanislaus River Watershed.

Table 3-48. Land Use Acreage according to DWR and FRAP Land Use Data for the Stanislaus River Watershed

Land Use	Acres	Percent Total
DWR Land Use Type		
Agriculture		
Deciduous Fruits and Nuts	8	0.0
Pasture	410	0.1
Semi agricultural and Incidental	117	0.0
Truck, Nursery, and Berry Crops	0.3	0.0
Vineyards	5	0.0
Subtotal	540	0.1
Urban		
Urban—Unclassified	703	0.1
Residential	2,553	0.4
Commercial	512	0.1
Industrial	299	0.0
Vacant	146	0.0
Subtotal	4,213	0.7

Land Use	Acres	Percent Total
Native		
Native Vegetation	501,410	78.6
Riparian Vegetation	230	0.0
Water Surface	11,701	1.8
Subtotal	513,341	80.5
FRAP Land Use Type		
Agriculture	156	0.0
Barren/Other	1,163	0.2
Conifer	39,831	6.2
Hardwood	33,489	5.2
Herbaceous	20,375	3.2
Shrub	16,001	2.5
Urban	2,195	0.3
Water	6,641	1.0
Wetland	131	0.0
Subtotal	119,982	18.8
Total	**638,076**	**100.0**

Basin Plan Status

The Sacramento and San Joaquin Rivers Basin Plan (Central Valley Water Board 2007b) describes beneficial uses for waters in the upper Stanislaus River Watershed. Table 3-49 lists the beneficial uses of the Stanislaus River from its source to Tulloch Reservoir.

Table 3-49. Beneficial Uses in the Stanislaus River Watershed

Beneficial Uses	Upper Stanislaus River (from source to Tulloch Reservoir)
Municipal & Domestic	E, P
Irrigation	E
Stock Watering	E
Process	
Service Supply	
Power	E
Rec-1*	E
Rec-2*	E
Freshwater Habitat—Warm	E
Freshwater Habitat—Cold	E
Migration—Warm	
Migration—Cold	
Spawning—Warm	
Spawning—Cold	

Beneficial Uses	Upper Stanislaus River (from source to Tulloch Reservoir)
Wildlife Habitat	E
Navigation	

P = Potential, E = Existing.

* Rec-1 indicates recreational activities involving body contact with water, where ingestion of the water is reasonably possible. These uses include, but are not limited to, swimming, wading, water skiing, skin and scuba diving, surfing, white water activities, fishing, and use of natural hot springs. Rec-2 indicates recreational activities involving proximity to water, but generally with no body contact with water or any likelihood of ingestion of water. These include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, and aesthetic enjoyment associated with the above activities.

Source: Central Valley Water Board 2007b.

Hydrology

The largest reservoir in the Stanislaus River Watershed is New Melones, with a capacity of 2,420,000 acre-feet. Reclamation operates New Melones Reservoir on the Stanislaus River, east of Oakdale, to provide water for agricultural, municipal, and industrial uses. New Melones is fed by the Upper Stanislaus River Watershed (approximately 900 square miles) (Figure 3-30). Some of the larger water storage facilities in the upper watershed are New Spicer Meadow Reservoir, which is along Highland Creek; Beardsley Lake and Donnell Lake along the Middle Fork Stanislaus River; and Pinecrest Lake along the South Fork Stanislaus River. The highest mean flows into New Melones occur in May and June, at 3,109 and 2,836 cfs, respectively. The lowest mean inflow occurs in November at 652 cfs. For minimum, mean, and maximum monthly average flows, see Table B-26 in Appendix B.

Water Quality

There are few, if any, water quality concerns in the upper Stanislaus River Watershed. No Section 303(d)-listed pollutants are associated with the Upper Stanislaus River or its tributaries. This is likely due to the dominance of native vegetation and low occurrence of urban, industrial, irrigated agriculture, or other developed land uses in this watershed. However, it is important to note that Stanislaus River water quality is degraded downstream of Tulloch Reservoir; and the river is impaired for four different pollutants. See the San Joaquin Valley Floor Watershed description for further information.

II.L Tuolumne River Watershed

General Description

The Tuolumne River Watershed covers approximately 1,034,000 acres (1,116 square miles) from the headwaters of the Tuolumne River high in the Sierra Nevada down to the San Joaquin Valley floor (see Figure 3-3). The upper Tuolumne River Watershed extends as far downstream as the Tuolumne River at La Grange, which is approximately 5 miles downstream of Don Pedro Reservoir. The Tuolumne River Watershed lies almost entirely within Tuolumne County. Its western edge follows the Stanislaus County line, its southern edge follows the Mariposa County line, and its eastern edge follows the Mono County line (Figure 3-31). The elevation in this watershed ranges from 177 to 13,031 feet. The major water bodies include the Tuolumne River, the Clavey River, and Don Pedro Reservoir.

The climate of the Tuolumne River watershed is highly variable because of the large range in elevation. At the lower elevations, the climate is arid to semi-arid with dry, hot summers and mild winters. Summer temperatures may be higher than 100°F, and winter temperatures are only occasionally below freezing. Conditions are cooler and there is more precipitation at the higher elevations. The winter snowpack, which accumulates above 5,000 feet elevation, supplies much of the water in this watershed.

Land Use Patterns

Native vegetation and riparian vegetation account for almost all of the land use in the upper Tuolumne River Watershed (Figure 3-43). Water surface accounts for slightly over 2 percent of the land type. Irrigated agriculture represents less than 1 percent of the land use in the watershed. Table 3-50 includes land use acreage according to DWR land use data for the upper Tuolumne River Watershed.

Table 3-50. Land Use Acreage according to DWR Land Use Data for the Tuolumne River Watershed

Land Use	Acres	Percent Total
Agriculture		
Deciduous Fruits and Nuts	253	0.0
Pasture	738	0.1
Truck, Nursery, and Berry Crops	25	0.0
Semi agricultural and Incidental	262	0.0
Subtotal	1,278	0.1
Urban		
Urban—Unclassified	3148	0.3
Urban Landscape	488	0.0
Urban Residential	13,835	1.3
Commercial	1,092	0.1
Industrial	897	0.1
Vacant	463	0.0
Subtotal	19,923	1.9

Land Use	Acres	Percent Total
Native		
Native Vegetation	990,086	95.8
Barren and Wasteland	14	0.0
Riparian Vegetation	633	0.1
Water Surface	22,026	2.1
Subtotal	1,012,759	97.9
Total	**1,033,961**	**100.0**

Although this watershed is outside of the Central Valley, there are no FRAP land use data for the Tuolumne River Watershed.

Basin Plan Status

The Sacramento and San Joaquin Rivers Basin Plan (Central Valley Water Board 2007b) describes beneficial uses for waters in the Tuolumne River Watershed. Table 3-51 lists the beneficial uses of the Tuolumne River from its source to Don Pedro Reservoir.

Table 3-51. Beneficial Uses in the Tuolumne River Watershed

Beneficial Uses	Tuolumne River (from Source to Don Pedro Reservoir)
Municipal & Domestic	E
Irrigation	E
Stock Watering	E
Process	
Service Supply	
Power	E
Rec-1*	E
Rec-2*	E
Freshwater Habitat—Warm	E
Freshwater Habitat—Cold	E
Migration—Warm	
Migration—Cold	
Spawning—Warm	
Spawning—Cold	
Wildlife Habitat	E
Navigation	

P = Potential, E = Existing, U = Undefined.

* Rec-1 indicates recreational activities involving body contact with water, where ingestion of the water is reasonably possible. These uses include, but are not limited to, swimming, wading, water skiing, skin and scuba diving, surfing, white water activities, fishing, and use of natural hot springs. Rec-2 indicates recreational activities involving proximity to water, but generally with no body contact with water or any likelihood of ingestion of water. These include, but are not limited to, picnicking, sunbathing, hiking,

Beneficial Uses	Tuolumne River (from Source to Don Pedro Reservoir)
beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, and aesthetic enjoyment associated with the above activities.	
Source: Central Valley Water Board 2007b.	

Hydrology

The largest reservoir in the Tuolumne River watershed is Don Pedro Reservoir, with a capacity of 2,030,000 acre-feet and a watershed of approximately 1,500 square miles. It provides flood control for the Tuolumne River, irrigation water supply for TID and Modesto ID, and domestic water supply for the Modesto area. Don Pedro is jointly operated by TID and Modesto ID.

The Tuolumne River originates in Yosemite National Park in Tuolumne Meadows, at the confluence of the Dana Fork and the Lyell Fork (Figure 3-31). Downstream of Tuolumne Meadows, the water flows into Hetch Hetchy Reservoir, owned by the City and County of San Francisco. Hetch Hetchy is the second largest reservoir on the Tuolumne River, with a capacity of 360,400 acre-feet. Both Hetch Hetchy and Lake Eleanor, a smaller reservoir with a storage capacity of 26,110 acre-feet, are located in Yosemite National Park. The Tuolumne River is listed as a Wild and Scenic River under the Wild and Scenic River Act, which was passed to protect designated rivers from degradation. The designated area is from its source to Don Pedro Reservoir.

Major tributaries to the Tuolumne River upstream of Don Pedro Reservoir include the North, South, and Middle Forks of the Tuolumne River; Cherry Creek; and the Clavey River. Cherry Lake is another large reservoir in the Tuolumne River watershed. It has a capacity of 274,300 acre-feet and is located on Cherry Creek. Some water from the South Fork of the Stanislaus River can enter the Tuolumne River watershed via the Tuolumne Canal for agricultural diversion near Long Barn.

The Clavey River is one of the longest undammed rivers in the Sierra Nevada. The Clavey flows from its source in alpine lakes in the Emigrant Wilderness (north of Yosemite National Park) for 47 miles to its confluence with the Tuolumne River.

Appendix B, Table B-27 contains the average inflow into Don Pedro Reservoir between 1995 and 2004. The values presented are the minimum, mean, and maximum of the monthly average values for data measured between 1995 and 2004. These flows are influenced primarily by rainfall, snowmelt, and operations at the upstream reservoirs. Diversion of water from the Hetch Hetchy to the Bay Area greatly influences the inflow into Don Pedro. The highest monthly average flows (up to 14,315 cfs) occur in winter and can extend through the spring snowmelt. The lowest monthly average flows (as low as 152 cfs) occur in late summer and fall.

Water Quality

Other than elevated mercury levels, there are no known water quality problems in the upper Tuolumne River Watershed. The USGS water quality database does not provide data for mercury in the water column in or near Don Pedro Reservoir. The determination of impairment was based on measurements of mercury in the tissue of predatory fish (largemouth bass). Between 1981 and 1987, 32 fish were sampled and found to have an average methylmercury concentration of 0.54 milligram per kilogram (mg/kg) (Central Valley Water Board 2005c). This is greater than the EPA criterion of 0.3 mg methylmercury/kg for fish (EPA 2001). Mercury is known to originate from mine drainage in the upper Tuolumne River Watershed.

III. TULARE LAKE BASIN

Introduction

The **Tulare Lake Basin** encompasses a drainage area from Fresno to the southern end of the Central Valley near the Grapevine (see Figure 3-1 for watershed boundaries). For the purposes of this analysis, the Tulare Lake Basin includes 10 watersheds: the (A) Kings River, (B) Kaweah River, (C) Kern River, (D) South Valley Floor, (E) Grapevine, (F) Coast Range, (G) Fellows, (H) Temblor Valley, (I) Sunflower Valley, and (J) Southern Sierra Watersheds.

Much of the topography within the Tulare Lake Basin is dominated by steep river canyons and large mountains, typical of the Sierra Nevada and Coast Ranges. The basin encompasses several land holdings, including Sequoia National Park, Sequoia National Forest, the Golden Trout Wilderness Area, and the Tule Indian Reservation. The basin also includes two Superfund cleanup sites, the Coalinga Asbestos Mine and the Atlas Asbestos Mine.

The Tulare Lake Basin encompasses approximately 10.7 million acres. Of this amount, 3.6 million acres are classified as agricultural. The vast majority of this agricultural land is located in the South Valley Floor Watershed (3.5 million acres), largely due to topography. In comparison with other watersheds in the Tulare Lake Basin, the South Valley Floor Watershed is relatively flat. Consequently, the bulk of water quality concerns related to the Tulare Lake Basin involve agricultural operations and agricultural return flows in the South Valley Floor Watershed.

Due to the amount of land in the Tulare Lake Basin that is in the Sierra Nevada and the Coast Ranges, most of the basin is dominated by native vegetation and includes little urban development. In the upper watershed areas, irrigated agriculture accounts for less than 2 percent of land uses in the Kings River, Kaweah River, Kern River, Grapevine, Coast Range, Sunflower Valley, and Southern Sierra Watersheds—with just slightly more in the Temblor Watershed (3.3 percent). There is no agriculture in the Fellows Watershed. The primary crop types within the Tulare Lake Basin as a whole are grain and hay crops, pasture, and deciduous fruits and nuts. The primary crop types within the South Valley Floor Watershed are field crops, followed by deciduous fruits and nuts, vineyards, pasture, and grain and hay.

Overview of Agricultural Impacts on Surface Water in the Tulare Lake Basin Watershed

In general, agricultural operations have a greater impact on surface water in the Central Valley between the Fresno area and the Tehachapi Mountains. This is primarily due to the rich fertile valley topography allowing for much larger agricultural operations.

Section 303d water quality concerns within the Tulare Lake Basin are limited to the South Valley Floor Watershed. None of the other watersheds include water bodies with Section 303(d)-listed pollutants, and all physical parameters such as EC, pH, temperature, and turbidity are generally within Basin Plan standards. Factors such as selenium and sedimentation are believed to be naturally occurring (with the exception of the South Valley Floor Watershed). However, some water bodies have water quality concerns that are not reflected in the Section 303(d) list, such as those for which there are no quantitative criteria to measure against or for which there is uncertainty regarding the magnitude or frequency of exceeding a criteria that would result in nonsupport of a particular beneficial use.

The **South Valley Floor Watershed** is the largest watershed within the Tulare Lake Basin, at approximately 5,270,363 acres (about 8,235 square miles). The watershed is located in the southern Central Valley and is bounded to the north by the San Joaquin River, to the south by the Tehachapi Mountains, on the west by the Coast Ranges, and on the east by the Sierra Nevada. As noted, the South Valley Floor Watershed is relatively flat compared to the surrounding watersheds. Agriculture is the primary land use type in the watershed, encompassing approximately 66 percent (3,485,592 acres) of the total land area.

Surface water in the South Valley Floor Watershed is not sufficient to support land uses in the watershed, resulting in a large proportion of water being imported from other locations. The Friant-Kern Canal, the San Luis Canal/California Aqueduct System, and the Cross-Valley Canal are major water delivery facilities that have dramatically altered the way water is managed in the South Valley Floor Watershed; water is moved from one end of the valley to the next as needed. The Tulare Lake Basin is hydrologically closed for all intents and purposes. Because of the intensive water development that has occurred in the watershed, very few channels are not specifically maintained as water delivery features and there is very little monitoring or characterization of the watershed's water quality.

During the irrigation season, water bodies in the South Valley Floor Watershed are dominated by agricultural return flows, which often transport pesticides to the various east side and west side drainages. In addition, pesticides that are applied during the dormant spray season, which typically occurs between November and January, can be transported from fields during rainfall events. Data indicate that chlorpyrifos, azinphos-methyl, dimethoate, malathion, thiobencarb, esfenvalerate, cypermethrin, toxephene, DDE, DDT, and DDD are present in concentrations that exceed water quality objectives. Copper also has been detected at multiple locations in the South Valley Floor Watershed. Copper is a naturally occurring metal that is also used as a pesticide. Other metals such as arsenic, cadmium, boron, lead, molybdenum, manganese, zinc, iron, and selenium have been detected at elevated levels and are likely mobilized by agricultural return flows.

Many of the creeks and drainages located in the South Valley Floor Watershed contain low DO. Factors contributing to low DO are currently under investigation but are possibly associated with nutrient loads from irrigated agriculture. In addition, many of the creeks in the watershed experience fluctuating levels of pH and elevated levels of EC. Toxicity tests indicate that non-polar organics are causing toxicity problems in the South Valley Floor Watershed. Non-polar organics, including chlorpyrifos, diazinon, dimethoate, disulfton, diuron, cyfluthrin, dioxathion, simazine, and atrazine, were found in some of the samples tested and were identified as likely or potential causes of observed toxicity.

A detailed analysis of the impacts on surface water in the Tulare Lake Basin is broken up by watersheds and described below.

III.A Kings River Watershed

General Description

The Kings River Watershed is located on the eastern side of the Central Valley near the south end of the valley (Figure 3-3). The two major water features in the upper Kings River Watershed are the Kings River and Pine Flat Reservoir. Pine Flat Reservoir makes up the lower boundary of the upper Kings River Watershed. Virtually all irrigated agriculture is located downstream of Pine Flat Reservoir. Elevations in the watershed vary from 832 to 11,599 feet, with an average elevation of 6,670 feet. Note that because the release from Pine Flat Dam is in the South Valley Floor Watershed, the dam and its released waters are discussed in detail in the South Valley Floor Watershed section.

The climate of the upper Kings River Watershed is highly variable because of the large range in elevation. At the lower elevations, the climate is arid to semi-arid with dry, hot summers and mild winters. Summer temperatures may be higher than 100°F, and winter temperatures are only occasionally below freezing. Conditions are cooler and there is more precipitation at the higher elevations. The winter snowpack, which accumulates above 5,000 feet elevation, supplies much of the water in this watershed.

Land Use Patterns

The majority of land use in the Kings River Watershed is made up of native vegetation (Figure 3-54). Urban land use accounts for less than 1 percent. Total irrigated agriculture also accounts for less than 1 percent. Table 3-52 shows the land use acreage for the upper Kings River Watershed according to DWR and FRAP land use data.

Table 3-52. Land Use Acreage according to DWR and FRAP Land Use Data for the Kings River Watershed

Land Use	Acres	Percent Total
DWR Land Use Type		
Agriculture		
Citrus and Subtropical	2,560	0.2
Deciduous Fruits and Nuts	55	0.0
Field Crops	10	0.0
Grain and Hay	5	0.0
Pasture	25	0.0
Semi agricultural and Incidental	33	0.0
Truck, Nursery, and Berry Crops	7	0.0
Subtotal	2,695	0.2
Urban		
Urban—Unclassified	3	0.0
Urban Landscape	1	0.0
Urban Residential	1,032	0.1
Industrial	0.02	0.0
Vacant	0.01	0.0

Land Use	Acres	Percent Total
Subtotal	1,036	0.1
Native		
Native Vegetation	96,826	8.2
Water Surface	3,409	0.3
Subtotal	100,235	8.5
FRAP Land Use Type		
Agriculture	121	0.0
Barren/Other	235,833	19.9
Conifer	530,543	44.8
Hardwood	181,667	15.4
Herbaceous	33,902	2.9
Shrub	79,947	6.8
Urban	466	0.0
Water	12,540	1.1
Wetland	4,548	0.4
Subtotal	1,079,567	91.2
Total	**1,183,534**	**100**

Basin Plan Status

The *Water Quality Control Plan for the Tulare Lake Basin* (Tulare Lake Basin Plan) (Central Valley Water Board 2004a) describes beneficial uses for waters in the Kings River Watershed. Table 3-53 lists the beneficial uses of the Kings River (Upper North Fork, Main Fork above Kirch Flat, and Kirch Flat to Pine Flat Dam).

Table 3-53. Beneficial Uses in the Kings River Watershed

	Kings River		
Beneficial Uses	Upper North Fork	Main Fork (above Kirch Flat)	Kirch Flat to Pine Flat Dam (Pine Flat Reservoir)
Municipal & Domestic		E	
Irrigation			
Stock Watering			
Proc			
Ind			
Power	E		E
Rec-1*	E	E	E
Rec-2*	E	E	E
Freshwater Habitat—Warm	E	E	E
Freshwater Habitat—Cold	E	E	E
SPWN	E	E	

	Kings River		
Beneficial Uses	Upper North Fork	Main Fork (above Kirch Flat)	Kirch Flat to Pine Flat Dam (Pine Flat Reservoir)
Wildlife Habitat	E	E	E
RARE	E	E	
Groundwater Recharge			
Fresh Water Replenishment	E	E	E

E = Existing.

RARE = Rare, threatened, or endangered species; SPWN = Spawning, reproduction, and or early development.

* Rec-1 indicates recreational activities involving body contact with water, where ingestion of the water is reasonably possible. These uses include, but are not limited to, swimming, wading, water skiing, skin and scuba diving, surfing, white water activities, fishing, and use of natural hot springs. Rec-2 indicates recreational activities involving proximity to water, but generally with no body contact with water or any likelihood of ingestion of water. These include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, and aesthetic enjoyment associated with the above activities.

Source: Central Valley Water Board 2004a.

Hydrology

The North Fork Kings River and the Main Fork Kings River flow into Pine Flat Reservoir (Figure 3-44). The many small tributaries on the North Fork of the Kings River include Dinkey Creek, Basin Creek, Patterson Creek, Weir Creek, Williams Creek, Teakettle Creek, Rancheria Creek, and Long Meadow Creek. The North Fork Kings River is a steep-sided canyon watershed; consequently, no irrigated agriculture is associated with this watershed, and these small tributaries are not discussed in detail.

At the confluence of the South Fork Kings River and the Middle Fork Kings River, the many small tributaries include Mill Flat Creek, Verplank Creek, Converse Creek, Spring Creek, Cabin Creek, Garlic Meadow Creek, Rough Creek, and Tenmile Creek. The South Fork Kings River tributaries include Lockwood Creek, Redwood Creek, and Boulder Creek—among others. The Middle Fork Kings River tributaries include Tombstone Creek, Wren Creek, Silver Creek, Crown Creek, and Crystal Creek—among others. This analysis does not discuss these small creeks in detail. The South Fork and Middle Fork Kings River also are steep-sided canyon watersheds, and there is virtually no agriculture within these watersheds. Portions of the Upper Kings River are listed as a Wild and Scenic River under the Wild and Scenic River Act, which was passed to protect designated rivers from degradation. The designated area extends from the confluence of the Middle Fork and the South Fork to a point at elevation 1,595 feet, from the Middle Fork from its headwaters at Lake Helen to its confluence with the mainstem, and from the South Fork from its headwaters at Lake 11599 to its confluence with the mainstem.

CDEC contains flow data for Kings River above Pine Flat Reservoir. Monthly average flows for the Kings River from 1997 to 2004 range from 30 to 1,000 cfs (see Table B-28 in Appendix B).

Water Quality

There are few, if any, water quality concerns in the upper Kings River Watershed. No Section 303(d)-listed pollutants are associated with the Upper Kings River. This is likely attributable to most of the upper watershed being included in the Kings Canyon National Park and the John Muir Wilderness. There is very little urbanization in the upper Kings River Watershed, and irrigated agriculture accounts for less than 1 percent of the land use. Generally, all physical parameters such as EC, pH, temperature, and turbidity are within Basin Plan standards. However, it is important to note that the Lower Kings River is listed on the 2006 Section 303(d) list as impaired for EC, molybdenum, and toxaphene. These impairments are discussed in detail in the South Valley Floor Watershed section.

III.B Kaweah River Watershed

General Description

The Kaweah River Watershed is located just south of the Kings River Watershed in the southern portion of the Central Valley (Figure 3-3). Its western boundary is defined where the foothills meet the valley floor. The upper Kaweah River Watershed is approximately 600,093 acres (about 938 square miles). The topography of the Kaweah River Watershed is similar to the Kings River Watershed. The minimum elevation is 400 feet, the average elevation is 4,080 feet, and the maximum elevation is 12,569 feet (DWR 2005c). The two major water features in the upper Kaweah River Watershed are Lake Kaweah and the Kaweah River. Because drainage from Lake Kaweah is outside of the watershed, it is discussed in the South Valley Watershed section. Figure 3-45 delineates the Kaweah River Watershed.

The climate of the Kaweah River Watershed is highly variable because of the large range in elevation. At the lower elevations, the climate is arid to semi-arid with dry, hot summers and mild winters. Summer temperatures may be higher than 100°F, and winter temperatures are only occasionally below freezing. Conditions are cooler and there is more precipitation at the higher elevations. The winter snowpack, which accumulates above 5,000 feet elevation, supplies much of the water in this watershed.

Land Use Patterns

Figure 3-55 illustrates the land use in the upper Kaweah River Watershed. Because this watershed is located in the higher elevations, the majority of land use is native vegetation. Urban land use accounts for less than 1 percent of the watershed. Irrigated agriculture accounts for only a small amount of the land use in the upper Kaweah River Watershed, primarily because of the watershed's topography. Total irrigated agriculture represents less than 1 percent of the watershed. Table 3-54 categorizes the land use acreage for the upper Kaweah River Watershed according to DWR and FRAP land use types.

Table 3-54. Land Use Acreage according to DWR and FRAP Land Use Data for the Kaweah River Watershed

Land Use	Acres	Percent Total
DWR Land Use Type		
Agriculture		
Citrus and Subtropical	2,205	0.4
Deciduous Fruits and Nuts	149	0.0
Field Crops	87	0.0
Grain and Hay	5	0.0
Idle	6	0.0
Pasture	76	0.0
Semi agricultural and Incidental	49	0.0
Vineyards	37	0.0
Subtotal	2,614	0.4

Land Use	Acres	Percent Total
Urban		
Urban—Unclassified	10	0.0
Urban Landscape	5	0.0
Urban Residential	240	0.0
Commercial	0.12	0.0
Industrial	6	0.0
Vacant	7	0.0
Subtotal	268	0.0
Native		
Native Vegetation	105,288	17.5
Riparian Vegetation	21	0.0
Water Surface	43	0.0
Subtotal	105,352	17.6
FRAP Land Use Type		
Agriculture	118	0.0
Barren/Other	29,057	4.8
Conifer	132,704	22.1
Hardwood	239,916	40.0
Herbaceous	48,954	8.2
Shrub	37,621	6.3
Urban	554	0.1
Water	2,726	0.5
Wetland	208	0.0
Subtotal	491,858	82.0
Total	**600,093**	**100**

Basin Plan Status

The Tulare Lake Basin Plan (Central Valley Water Board 2004b) describes beneficial uses for waters in the Kaweah River Watershed. Table 3-55 lists the beneficial uses of the Upper Kaweah River and Kaweah Lake.

Table 3-55. Beneficial Uses in the Kaweah River Watershed

	Kaweah River	
Beneficial Uses	Above Lake Kaweah	Lake Kaweah
Municipal & Domestic	E	
Irrigation		
Stock Watering		
Proc		
Ind		

	Kaweah River	
Beneficial Uses	Above Lake Kaweah	Lake Kaweah
Power	E	E
Rec-1*	E	E
Rec-2*	E	E
Freshwater Habitat—Warm	E	E
Freshwater Habitat—Cold	E	
SPWN	E	
Wildlife Habitat	E	E
RARE	E	
Groundwater Recharge		
Fresh Water Replenishment	E	E

E = Existing.

RARE = Rare, Threatened, or Endangered Species. SPWN = Spawning, reproduction, and or early development.

* Rec-1 indicates recreational activities involving body contact with water, where ingestion of the water is reasonably possible. These uses include, but are not limited to, swimming, wading, water skiing, skin and scuba diving, surfing, white water activities, fishing, and use of natural hot springs. Rec-2 indicates recreational activities involving proximity to water, but generally with no body contact with water or any likelihood of ingestion of water. These include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, and aesthetic enjoyment associated with the above activities.

Source: Central Valley Water Board 2007b.

Hydrology

The Upper Kaweah River contains three main arms: the North, Middle, and South Forks (Figure 3-45). All three arms combine to form Lake Kaweah. Each arm of the Kaweah has many smaller tributaries. Some of the main tributaries to the North Fork Kaweah are Mankins Creek, Sheep Creek, Yucca Creek, Eshom Creek, Pierce Creek, Redwood Creek, Stoney Creek, Marble Fork, and Dorst Creek. It is important to note that the Middle Fork Kaweah also has an East Fork Kaweah branch. The Middle Fork Kaweah is by far the largest of the three arms. Some of the main tributaries that make up the Middle Fork Kaweah River include Salt Creek, the East Fork Kaweah River, Squirrel Creek, Elk Creek, Panther Creek, Dome Creek, Castle Creek, Mehrten Creek, Buck Creek, Cliff Creek, Granite Creek, and Lone Pine Creek. Some of the main tributaries that make up the South Fork Kaweah River include Gray Creek, Cinnamon Creek, Grouse Creek, Bennett Creek, Squaw Creek, Cedar Creek, Garfield Creek, and Hunter Creek. Many of these smaller tributaries are ephemeral streams, depending on the amount of snow pack or the duration of a storm.

For this analysis, only the three main arms are discussed in further detail due to the lack of data on all of the smaller tributaries. The USGS website contains flow information for various locations on the Kaweah River. However, the Middle Fork Kaweah River is the only arm that contains flows just above Lake Kaweah. The Kaweah River below Lake Kaweah is in the South Valley Floor Watershed and is further discussed in that section. Monthly average USGS flows for the Middle Fork Kaweah River from 1985 to 1990 range from 10 to 2,000 cfs (see Table B-29 in Appendix B).

Water Quality

The Southern San Joaquin Valley Water Quality Coalition monitored four locations on the lower Kaweah River. For one sampling event, the water quality data did not indicate that agricultural contamination was present (SJVWQC 2005). However, it is important to note that these four sampling locations were downstream of Kaweah Lake and are outside of the upper Kaweah River Watershed. The State of the Watershed Report for Tulare Lake Watershed in the Water Management Initiative noted that Kaweah Basin contained elevated levels of copper, arsenic, and silver that are thought to be naturally occurring (Central Valley Water Board and CalEPA 2002). The Kaweah River is not listed on the 2006 Section 303(d) list for any impairment.

III.C Kern River Watershed

General Description

The Kern River Watershed is the second largest watershed in the Tulare Lake Basin and covers approximately 1,517,632 acres (2,371 square mile). The Kern River Watershed is bordered to the north by the Kings River Watershed, on the west by the Southern Sierra Watershed, on the east by the Sierra Nevada, and to the south by the Grapevine Watershed (Figure 3-3). The topography of the upper Kern River Watershed is similar to the Kings River and Kaweah River Watersheds and is dominated by steep river canyons and large mountains. The minimum elevation is 489 feet, the mean elevation is 6,791 feet, and the maximum elevation is 14,478 feet. Figure 3-46 shows the Kern River Watershed boundaries.

The primary water features in the upper Kern River Watershed are the Kern River, South Fork Kern River, Isabella Lake, and Kern River outflow from Isabella Lake.

The climate of the Kern River Watershed is highly variable because of the large range in elevation. At the lower elevations, the climate is arid to semi-arid with dry, hot summers and mild winters. Summer temperatures may be higher than 100°F, and winter temperatures are only occasionally below freezing. Conditions are cooler and there is more precipitation at the higher elevations. The winter snowpack, which accumulates above 5,000 feet elevation, supplies much of the water in this watershed.

Land Use Patterns

Figure 3-56 illustrates the land use in the upper Kern River Watershed. Urban land use accounts for a very small portion, less than 1 percent, of the land use in the upper Kern River Watershed. The total irrigated land in the watershed is also less than 1 percent of the watershed. Table 3-56 identifies land use acreage according to DWR and FRAP land use data for the upper Kern River Watershed.

Table 3-56. Land Use Acreage according to DWR and FRAP Land Use Data for the Kern River Watershed

Land Use	Acres	Percent Total
DWR Land Use Type		
Agriculture		
Citrus and Subtropical	69	0.0
Deciduous Fruits and Nuts	55	0.0
Field Crops	18	0.0
Grain and Hay	795	0.1
Idle	44	0.0
Pasture	2,943	0.2
Semi agricultural and Incidental	103	0.0
Truck, Nursery, and Berry Crops	693	0.0
Subtotal	4,720	0.3

Land Use	Acres	Percent Total
Urban		
Urban—classified	2,525	0.2
Urban Landscape	82	0.0
Urban Residential	3,230	0.2
Commercial	154	0.0
Industrial	57	0.0
Vacant	124	0.0
Subtotal	6,172	0.4
Native		
Native Vegetation	213,174	14.0
Riparian Vegetation	3,182	0.2
Water Surface	10,810	0.7
Subtotal	227,166	15.0
FRAP Land Use Type		
Barren/Other	110,061	7.3
Conifer	795,863	52.4
Desert	39,596	2.6
Hardwood	98,752	6.5
Herbaceous	50,865	3.4
Shrub	166,111	10.9
Urban	608	0.0
Water	2,666	0.2
Wetland	15,053	1.0
Subtotal	1,279,575	84.3
Total	**1,517,632**	**100**

Basin Plan Status

The Tulare Lake Basin Plan (Central Valley Water Board 2004b) describes beneficial uses for waters in the Kern River Watershed. Table 3-57 lists the beneficial uses of the Kern River (above Lake Isabella, Lake Isabella, and from Lake Isabella to Kern River Powerhouse No.1).

Table 3-57. Beneficial Uses in the Kern River Watershed

	Kern River		
Beneficial Uses	Above Lake Isabella	Lake Isabella	Lake Isabella to Kern River Powerhouse No. 1
Municipal & Domestic	E		
Irrigation			
Stock Watering			
Process			
Ind			

Beneficial Uses	Kern River		
	Above Lake Isabella	Lake Isabella	Lake Isabella to Kern River Powerhouse No. 1
Power	E	E	E
Rec-1*	E	E	E
Rec-2*	E	E	E
Freshwater Habitat—Warm	E	E	E
Freshwater Habitat—Cold	E	E	E
SPWN	E		
Wildlife Habitat	E		E
RARE	E		E
Groundwater Recharge			
Freshwater Replenishment	E	E	

E = Existing.

RARE = Rare, threatened, or endangered species; SPWN = Spawning, reproduction, and/or early development.

* Rec-1 indicates recreational activities involving body contact with water, where ingestion of the water is reasonably possible. These uses include, but are not limited to, swimming, wading, water skiing, skin and scuba diving, surfing, white water activities, fishing, and use of natural hot springs. Rec-2 indicates recreational activities involving proximity to water, but generally with no body contact with water or any likelihood of ingestion of water. These include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, and aesthetic enjoyment associated with the above activities.

Source: Central Valley Water Board 2004b.

Hydrology

Kern River

The headwaters of the Kern River originate in the Kings Kern Divide, from which the river travels through Kern Canyon in Sequoia National Park (Figure 3-56). The Kern River flows south, passing west of Mt. Whitney and through the Golden Trout Wilderness Area. Along its route, the Kern River has many small tributary creeks. The west side tributaries from north to south include Milestone Creek, Red Spur Creek, Chagoopa Creek, Funston Creek, Big Arroyo Creek, Rattlesnake Creek, Laurel Creek, Coyote Creek, Little Kern Lake Creek, Grasshopper Creek, Leggett Creek, Little Kern River, Freeman Creek, Needle Rock Creek, Peppermint Creek, Meadow Creek, South Creek, Tobias Creek, and Bull Run Creek. After Bull Run Creek, the Kern River becomes the North Fork arm of Isabella Lake. The east side tributaries include Tundall Creek, Wallace Creek, Whitney Creek, Rock Creek, Golden Trout Creek, Cold Creek, Nine Mile Creek, Osa Creek, Soda Creek, Rattlesnake Creek, Durrwood Creek, Brush Creek, Salmon Creek, Gold Ledge Creek, Corral Creek, Cannell Creek, and Caldwell Creek. No flow data are available for this part of the Kern River. However, downstream flow data are available and are discussed in the South Valley Floor Watershed section.

The Kern River is listed as a Wild and Scenic River under the Wild and Scenic River Act, which was passed to protect designated rivers from degradation. The designated area is the North Fork from the

Tulare-Kern County line to its headwaters in Sequoia National Park and the South Fork from its headwaters in the Inyo National Forest to the southern boundary of the Domelands Wilderness in the Sequoia National Forest.

South Fork Kern River

The headwaters of the South Fork Kern River originate just southeast of the main Kern River next to the Golden Trout Wilderness Area, from which the river travels down through the Rainshaw and Templeton Meadows (Figure 3-56). As the South Fork flows south through the South Sierra Wilderness Area, many small creeks join the river. The west side creeks from north to south include Kern Peak Stringer, Lewis Stringer, Strawberry Creek, Shaeffer Stringer, Soda Creek, Round Mt. Stringer, Snake Creek, Crag Creek, Lost Creek, Bitter Creek, Fish Creek, Trout Creek, Tibbets Creek, Manter Creek, Taylor Creek, and Bartolas Creek, after which the South Fork Kern River becomes the South Fork arm of Isabella Lake. The east side tributaries of the South Fork Kern River include Mulkey Creek, Dry Creek, Long Stringer, Monache Creek, Summit Creek, Honeybee Creek, Canebrake Creek, and Kelso Creek. Monthly average flow for the South Fork Kern River ranges from 1 cfs during the dry season to up to 1,500 cfs during the storm season and is included in Appendix B, Table B-30.

Isabella Lake, also located in Sequoia National Forest, has a storage capacity of 568,000 acre-feet (DWR 2005d). From Isabella Dam, the Kern River flows southwest into the valley floor, passes through Bakersfield, and ultimately empties into the Outlet Canal that feeds the East and West Side Canal. Once the Kern River reaches the valley floor, it is outside of the Kern River Watershed; this part of the river is a part of the South Valley Floor Watershed. Monthly average flow of the Kern River from the USGS website is shown in Appendix B, Table B-30 and ranges from 200 to 4,500 cfs. Flow at Kern River near Democrat Springs, just downstream of Isabella Dam, is the total outflow from Isabella Dam and represents the combination of inflow from the main Kern River and the South Fork Kern River.

Water Quality

There are few, if any, water quality concerns in the upper Kern River Watershed. No 2006 Section 303(d)-listed pollutants are associated with the Upper Kern River. This is likely attributable to this watershed’s location primarily in the Sequoia National Park, Sequoia National Forest, and Golden Trout Wilderness Area. There is very little urban development or irrigated agriculture in this watershed. Generally, all physical parameters such as EC, pH, temperature, and turbidity are within Basin Plan standards.

III.D South Valley Floor Watershed

General Description

The South Valley Floor Watershed (SVF Watershed) is located in the southern Central Valley and is bounded to the north by the San Joaquin River and to the south by the Tehachapi Mountains (Figure 3-3). On the west are the Coast Ranges, and the Sierra Nevada are on the east. The SVF Watershed is the largest watershed in the Tulare Lake Basin, at approximately 5,270,363 acres (about 8,235 square miles). Figure 3-47 delineates the boundaries for the SVF Watershed. The general topography of the SVF Watershed is relatively flat in comparison to the surrounding watersheds. Elevation ranges from 154 feet in the lowest areas, to 4,131 feet at the base of some of the dams (USGS 2005a). The main natural water features in the SVF Watershed include the Kings River, the Kaweah River, the Tule River, the Kern River, and the west side drainages. The Friant-Kern Canal, the San Luis Canal, and the Cross-Valley Canal are major water delivery facilities that have dramatically altered the way water is managed in the SVF Watershed.

The climate is typically Mediterranean, with wet winters and dry summers. Snow may occur in the upper elevations; however, snow does not accumulate in sufficient quantities to provide additional summer flows in the SVF Watershed.

Surface water in the SVF Watershed is not sufficient to support land uses in the watershed, resulting in a large proportion of imported water from other locations. Imported surface water supplies include the San Luis Canal/California Aqueduct System, Friant-Kern Canal, and the DMC. The State Water Project (SWP), through the San Luis Reservoir, delivers an average of 1,200,000 acre-feet of surface water annually to the Tulare Lake Basin. Reclamation delivers a combined 2,700,000 acre-feet to the Tulare Basin, during normal years, from the CVP via Mendota Pool, the Friant-Kern Canal, and San Luis Canal of the CVP/SWP San Luis Joint-Use Facilities (DWR 2005b). The majority of this water is used in the SVF Watershed.

Land Use Patterns

Figure 3-57 illustrates that agriculture is the largest land use type in the SVF Watershed, encompassing approximately 67 percent of the total land area. Native vegetation encompasses approximately 25 percent of the total acreage in the area. Urban-land uses represent about 6 percent. Table 3-58 shows land use acreage according to DWR and FRAP land use data for the SVF Watershed.

Table 3-58. Land Use Acreage according to DWR and FRAP Land Use Data for the South Valley Floor Watershed

Land Use	Acres	Percent Total
DWR Land Use Type		
Agriculture		
Citrus and Subtropical	218,174	4.1
Deciduous Fruits and Nuts	524,082	9.9
Field Crops	1,199,547	22.8
Grain and Hay	343,311	6.5

Land Use	Acres	Percent Total
Idle	43,986	0.8
Pasture	394,170	7.5
Rice	14	0.0
Semi agricultural and Incidental	65,585	1.2
Truck, Nursery, and Berry Crops	285,520	5.4
Vineyards	454,367	8.6
Subtotal	3,528,756	67.0
Urban		
Urban—Unclassified	175,777	3.3
Urban Landscape	13,718	0.3
Urban Residential	36,778	0.7
Commercial	10,602	0.2
Industrial	60,789	1.2
Vacant	47,990	0.9
Subtotal	345,654	6.6
Native		
Native Vegetation	1,082,402	20.5
Barren and Wasteland	56	0.0
Riparian Vegetation	41,848	0.8
Water Surface	59,292	1.1
Subtotal	1,183,598	22.5
FRAP Land Use Type		
Agriculture	821	0.0
Desert	29,424	0.6
Hardwood	1,183	0.0
Herbaceous	171,946	3.3
Shrub	1,224	0.0
Urban	7,490	0.1
Water	272	0.0
Subtotal	212,360	4.0
Total	**5,270,368**	**100**

Basin Plan Status

The Tulare Lake Basin Plan (Central Valley Water Board 2004a) describes beneficial uses for waters in the SVF Watershed. Table 3-59 lists the beneficial uses of the Lower Kings River (Pine Flat Dam to Stinson and Empire Weirs), Lower Kaweah River (below Lake Kaweah), Lower Tule River (below Lake Success), Lower Kern River (below Southern California Edison's Kern River Powerhouse No. 1), west side streams, and valley floor waters.

Table 3-59. Beneficial Uses in the South Valley Floor Watershed

Beneficial Uses	Kings River (Pine Flat Dam to Stinson and Empire Weirs)	Kaweah River (below Lake Kaweah)	Tule River (below Lake Success)	Kern River (below KR-1)	West Side Streams	Valley Floor Waters
Municipal & Domestic	E	E	E	E		
Agriculture	E	E	E	E	E	E
Industrial Service		E	E	E	E	E
Industrial Process	E	E	E	E	E	E
Hydropower Generation	E			E		
Water Contact Recreation	E	E	E	E	E	E
Non-Contact Water Recreation	E	E	E	E	E	E
Freshwater Habitat—Warm	E	E	E	E	E	E
Freshwater Habitat—Cold	E					
Wildlife Habitat	E	E	E	E	E	E
Rare, Threatened, or Endangered Species				E	E	E
Spawning, Reproduction, and/or Early Development	E					
Groundwater Recharge	E	E	E	E	E	E
Freshwater Replenishment	E					
Preservation of Biological Habitats of Special Significance						

E=Existing. KR-1: Southern California Edison's Kern River Powerhouse No. 1.

Tulare Lake Basin Plan Beneficial Uses categories vary slightly from the Sacramento and San Joaquin Rivers Basin Plan Beneficial Uses categories.

The Kings River is further subdivided by the Tulare Lake Basin Plan, as follows:

- Reach I—above Kirch Flat,
- Reach II—Kirch Flat to Pine Flat Dam,
- Reach III—Pine Flat Reservoir to the Friant Kern Canal,
- Reach IV—Friant Kern Canal to Peoples Weir, and
- Reach V—Peoples Weir to Island Weir.

The Kings River Conservation District recognizes two additional reaches, as follows:

- Reach VI—Island Weir to Stinson Weir on the North Fork of the Kings River and to the Empire Weir No. 2 on the South Fork, and
- Reach VII—Stinson Weir to the James Weir on the North Fork of the Kings River (Kings River Conservation District 2000).

Hydrology

The dominant land use and industry in the SVF Watershed is irrigated agriculture. Fresno, Tulare, Kings, and Kern Counties are among the most productive agricultural counties in the world. Much of the water that once maintained historic Tulare and Buena Vista Lakes has been captured by reservoirs and is now used extensively to produce crops. Much of the water distribution system is comprised of historic river channels and sloughs and water is moved from one end of the valley to the next as needed.

On the west side of the valley, irrigation water is supplied through the San Luis Canal, which is the joint federal/state section of the California Aqueduct that delivers water from the Delta and San Luis Reservoir. On the east side of the valley, water is supplied from Millerton Lake through various turnouts on the Friant-Kern Canal. The Cross Valley Canal is a locally owned facility and is operated through a joint use agreement. The Friant-Kern Canal is operated by Reclamation and can deliver water to any number of contract and non-contract holders through various physical and institutional arrangements. Pine Flat Reservoir, Lake Kaweah, Lake Success, and Lake Isabella are operated by the Corps and likewise can deliver water to any number of contractors.

Many of the larger landholders in the basin have either contracts or agreements to use water from many of the reservoirs in the area and can take water through numerous facilities. An example is the Arvin-Edison Water Storage District that contracts for water from Millerton Reservoir but also has the capability through exchange agreements to store water from the California Aqueduct via the Cross Valley Canal. In another example, Fresno ID has contracts with Reclamation for Millerton Reservoir water and with the Corps for Kings River Water. Many of the irrigation districts and landholders also have agreements among themselves to exchange water in various year types and under certain circumstances. Because of the relatively dry conditions in the Tulare Lake Basin, most water in the basin is spoken for except in very wet conditions when there is not enough local surface storage to capture large flows. There also are numerous agreements between water storage districts and water agencies in the valley and State Water Contractors to store water in groundwater banks in the SVF Watershed for withdrawal or exchange during dry years.

While providing irrigation water, many of the reservoirs also were constructed to minimize flooding in the Tulare Lake Bed. This area has been intensively farmed for decades and very little water flows to the San Joaquin River through North Kings River. Because of the intensive water development that has occurred in the SVF Watershed, and in the watersheds directly to the east in the Sierra Nevada foothills, very few channels are not specifically maintained as water delivery features. While many of the historic channels provide recreation and fishing for some distance from the five main reservoirs in the foothills, flow in all of these channels is managed to provide irrigation and domestic supplies to water users in the SVF Watershed. This manipulation and commingling of many water sources has changed the hydrology and water quality characteristics of the basin. Because many of the once natural channels are maintained as water delivery features, little monitoring or characterization of the water quality has occurred—except by those who rely on these features for their livelihood.

The Friant-Kern Canal diverts water from the San Joaquin River below Friant Reservoir and travels south to deliver water to the southern portions of Kern County. The 151.8-mile Friant-Kern Canal stretches from Millerton Lake to the Kern River, 4 miles west of Bakersfield. Turnouts exist for Little Dry Creek, Kings River, Cottonwood Creek, St. Johns River, Porter Slough, Tule River, Deer Creek, White River, Poso Creek, and the Kern River. In wet years, the Friant-Kern Canal is used to transport flood flows out of the Basin via pumps/inlets from the Kings, Kaweah, St. Johns and Tule Rivers to the Kern River Intertie and the Cross Valley Canal into the California Aqueduct. Initial capacity of the canal is 5,000 cfs and gradually decreases to 2,000 cfs as water is used for municipal, industrial, and irrigation supplies throughout the South Valley (Reclamation 2005).

Water from the California Aqueduct flows into O'Neill Forebay and water from the DMC can be pumped into O'Neill Forebay. From there, water is either pumped into San Luis Reservoir for storage or continues south in the San Luis Canal. When necessary, often during the irrigation months, stored water from San Luis Reservoir is released back to O'Neill Forebay and either flows south in San Luis Canal to both CVP and SWP contractors, including many in the SVF Watershed, or is released to the DMC for delivery to CVP Exchange Contractors (CALFED 2003). Water also can be moved between the Friant-Kern Canal and the San Luis Canal through the Cross Valley Canal.

Lower Kings River

The Lower Kings River originates in the southern Sierra Nevada and flows west toward the Tulare Basin (Figure 3-47). This analysis covers the lower portion of water delivery systems, following natural hydrology—such as the Kings River from Pine Flat Reservoir to the Tulare Lake Canal. Just below Pine Flat Reservoir, the river flows southwest in a single channel and passes near Centerville where it splits into multiple channels and then converges as a single channel downstream of Centerville Bottoms. Near Kingsburg, the river is confined by a continuous levee system that continues through the lower reaches of the river. Below Empire Weir No. 2, the Kings River travels approximately nine miles south, where it merges with the Tule River Canal. A portion of Kings River water is diverted from Empire Weir No. 2 pool to the Tulare Lake Canal.

Army Weir, located at the head of the Clarks and South Fork, is the main flow diversion in the Kings River System. The Crescent Bypass, when operated in conjunction with the Crescent Weir, provides a secondary diversion to the South Fork. However, the Crescent Weir also can relay water back and forth between the two forks. The Kings River system capacity progressively decreases downstream, from 50,000 cfs below Pine Flat Dam to 11,000 cfs at the head of Army Weir due to diversions into a large system of canals. Data indicate that flow does not typically exceed 5,000 cfs in high-flow months, and low-flow months can have no flow (see Appendix B, Table B-28) (Kings River Conservation District 2005). During extreme high flow conditions, the Kings River spills into the Fresno Slough and flows into the San Joaquin River. These flood flows represent the most significant outflows from the basin (Kings River Conservation District 2005).

Lower Kaweah River

The Kaweah River originates in the Sierra Nevada at an elevation of 12,000 feet, flowing generally westward toward the South Valley. The South Valley portion of the Kaweah River Watershed includes Lower Kaweah River below Terminus Reservoir and St. Johns River. The main tributaries to this segment of the Lower Kaweah River are Dry Creek and Yokohl Creek. Annual spring runoff from Dry Creek provides sufficient inflow to contribute to the Kaweah River's flow. The intermittent Yokohl Creek has adequate flow to reach Kaweah River only during years with above-normal precipitation (Kaweah and St. Johns Rivers Association 2005). The Lower Kaweah splits into several smaller channels; from north to south they are: Mill Creek, Packwood Creek, Cameron Creek, inside/outside CK and Elk Bayou.. Mill Creek discharges into Cross Creek; Packwood Creek discharges into Packwood Ditch, which in turn discharges into Bates Slough, Cameron Creek terminates into the Homeland Canal, and Elk Bayou formed by inside and outside creeks discharges into the Tule River. The City of Visalia discharges its treated effluent into Mill Creek, which ultimately flows into Cross Creek.

The Friant-Kern Canal plays a large role in the hydrology of the Kaweah River. Exeter, Ivanhoe, Stone Corral, and Tulare IDs have long-term water service contracts with Reclamation for CVP water. Water is delivered through turnouts, where the Friant-Kern Canal crosses the Tulare ID Main Canal, the St. Johns River channel, and the Lower Kaweah River channel. The principal diversions from the lower Kaweah River below McKay’s Point are: Hamilton Ditch, Consolidated Peoples Ditch, Deep Creek, Crocker Cut, Tulare Irrigation Company Ditch, Fleming Ditch, Packwood Creek, Oakes Ditch, Evan’s Ditch, Persian Ditch, and Watson Ditch.

St. Johns River

The St. Johns River originates from the Kaweah River downstream of Terminus Reservoir at McKay Point. The river flows southwest until it bends northwest of Visalia and becomes Cross Creek approximately two miles east of Highway 99 at its junction with Cottonwood Creek. Water from Cross Creek is diverted into Lakeside Ditch and into Lakeland Canal No. 2 where it is mingled with Kings River water and is delivered to Tulare Lake and Kings River water users. Cross Creek terminates into the Lakeland Canal and the Tule River Canal. Several agricultural irrigation diversions reduce the flow of the St. Johns River prior to its reaching Cross Creek. These diversions include Longs Canal, Sweeney Ditch, Ketchum Ditch, Packwood Canal, Tulare ID Main Canal, Mathews Ditch, Jennings Ditch, Uphill Ditch, Modoc Ditch, St. Johns Ditch, Goshen Ditch, Lakeside Ditch, and Lakelands Canal No. 2. Major public irrigation districts in the Kaweah River system include Tulare ID, Exeter ID, Ivanhoe ID, Lakeside Water District, a portion of Corcoran ID, and Stone Corral ID. Water is diverted from the St. Johns and Lower Kaweah Rivers and distributed through a complex system of natural channels and manmade canals owned and operated by numerous agencies and entitlement holders.

Other foothill watersheds have the potential to generate runoff that reaches the southern San Joaquin Valley floor but only in above-average precipitation conditions. These watersheds include Sand Creek, Stokes Mountain, Cottonwood Creek, and Lewis Creek (Kaweah and St. Johns Rivers Associations 2005).

Lower Tule River

The North, Middle, and South Forks of the upper portion of the Tule River flow out of the Sierra Nevada foothills into Lake Success. Below Lake Success, the Tule River enters the SVF Watershed, flowing through Porterville and across the southern San Joaquin Valley floor for about 40 miles to the Tulare Lakebed. Porter Slough, which begins at the Tule River downstream of Bartlett Park, is used for diverting flood and irrigation releases from Success Reservoir. The Tule River divides into South, Middle, and North Forks north of the community of Woodville; the river remains divided for several miles. The South and Middle Forks reunite east of SR 99, and the South and North Forks reunite west of SR 99.

There are numerous irrigation diversions along the Tule River and many connecting inflows from the Kaweah River that enter Tule River prior to reaching the Tulare Lakebed, including Elk Bayou and Cross Creek. Tule River water reaching the Tulare Lakebed is stored for future irrigation or evaporates (Tule River Association 2005). The main irrigation districts include the Terra Bella, Saucelito, Porterville, Lindmore, Lower Tule River, Delano-Earlimart, and Pixley IDs. Natural flow in the Lower Tule River is highly manipulated by these irrigation districts. During summer, the irrigation districts routinely take water from the natural channels, leaving the channels dry. The water is then run through canals and discharged back to the river channels, resulting in alternating wet and dry lengths of the river system. The Friant-Kern Canal also plays a large role in providing flow in Tule River during summer.

Deer Creek and White River

Deer Creek and the White River are both located south of the Tule River and flow west toward Tulare Lake Basin from the Sierra Nevada foothills. Deer Creek near Fountain Springs typically flows year-round, with reduced flows from August through October, and provides flow to the Pixley NWR. In dry years, there is no flow in August and September. The highest average flows occur in February (82 cfs). The month with the highest average flow for a single year was January 1997, with a flow of 440 cfs (see Appendix B, Table B-31). Further downstream, near Road 104, Dear Creek is channelized and flows into Homeland Canal.

White River, near Ducor, has a reduced flow during average years and no flow from June through November during dry years. In wet years, April has the most flow (165 cfs) and the lowest flow occurs during September (5 cfs) (Appendix B, Table B-31). Deer Creek and White River also are largely uncontrolled, and threats of flooding occur during locally heavy rainstorms.

Lower Kern River

While there are some minor streams in the Lower Kern River Watershed, such as Poso Creek and Caliente Creek, the Kern River is the only significant natural source of surface water. The Kern River originates in Sequoia National Park North of Mt. Whitney. Several creeks drain into the Kern River as traverses the Kern River Gorge on its way to Lake Isabella. The waters of the upper Kern River originate as snowmelt from feeder creeks on public lands in the national park or national forest. Since 1954, when Isabella Dam was completed, all of the Kern River flow has been diverted into conveyance canals below Kern River Canyon. The diverted water is either consumptively used or recharged to groundwater and does not reenter the Kern River. In some years, the Kern County Water Agency and the City of Bakersfield provide water in the Kern River Channel through the City of Bakersfield for recreation. However, this occurs only in years when there is adequate river flow above the major diversions.

At Kern River Canyon, average flows are lowest in November (153 cfs) and highest in June (812 cfs). The Lower Kern River merges into Bueno Vista Lake. From Bueno Vista Lake, a historical lake at the southern end of the San Joaquin Valley that is now mostly dry, the drainage is a flood channel that locals typically refer to as the “North Fork of the Kern River.” For much of its length, the river channel is bordered by major conveyance canals, including Cross Valley Canal to the north and Carrier Canal to the south.

Diversion canals also are located along the Lower Kern River. The Beardsley-Lerdo and Calloway Canals deliver Kern River water north to the Cawelo Water District, the North Kern Water Storage District, and the Shafter-Wasco Irrigation District. The Kern Island Canals deliver water to the Arvin-Edison Water Storage District and the Kern Delta Water District. The Buena Vista, Stine, and Farmers Canals deliver water to the Kern Delta and the Buena Vista Water Storage District (BVWSD). The Arvin-Edison Canal delivers water to the Arvin-Edison Water Storage District. The Alejandro Canal, a lined canal, proceeds south into the Buena Vista Aquatic Lakes. BVWSD diverts water from the lakes into the BVWSD’s Outlet Canal, which proceeds to the BVWSD’s intake facilities and to BVWSD’s canals that serve District landowners. Through urban Bakersfield, flood control levees protect the river’s water quality from discharges. When the river is dry, there are intentional surface water discharges from either the Friant-Kern Canal or Cross Valley Canal into the Kern River channel for groundwater recharge (Kern County Water Agency 2005).

In addition, Poso and Caliente Creeks are part of the Kern River Watershed. Both creeks are normally dry except for high water years, and both receive canal discharges in summer; this results in alternating wet and dry portions of the stream channel. The western end of the Kern River also supports the Kern Water Bank. However, the majority of the water that feeds the bank is supplied by the California Aqueduct.

West Side Drainages

A multitude of ephemeral streams originating in the Coast Ranges and Tehachapi and San Emigdio Mountains make up the west side drainages. These stream channels cut through and drain from marine sediments and are highly mineralized. Most of these streams consist of flashy pulse flows. Sustained flow is limited, occurring only after extended wet periods (Central Valley Water Board 2004b). For further information on these drainages, see the descriptions for the Coast Range, Sunflower, Temblor, and Fellows Watersheds.

Tulare Lake Bed

During high flow, the Tulare Lake Bed serves as the terminus for both east side and west side valley streams, including runoff from the Kings, Kaweah, Tule, and Kern Rivers. This lakebed, with a bottom elevation of 175 feet is effectively closed. The only natural outlet is the San Joaquin River to the north at an elevation of 207 feet. Water has not risen to this elevation and naturally flowed out of the basin since the 1870s. Development of intensive agriculture in the tributary basins, construction of reservoirs and other flood and water control measures, and land reclamation in the lakebed have greatly reduced the likelihood of future natural outflows (Kings River Conservation District 2004).

Water Quality

Based on evaluation of data available from multiple sampling locations in the SVF Watershed, water quality conditions in most water bodies of the SVF Watershed are highly influenced by agricultural operations. During the irrigation season, water bodies of the SVF Watershed are comprised of flows for irrigation purposes and a small percentage of agricultural return flows. In addition, pesticides are applied during the dormant spray season, which typically occurs between November and January, and can be transported from fields during rainfall events. Data indicate that chlorpyrifos, azinphos-methyl, dimethoate, malathion, thiobencarb, esfenvalerate, cypermethrin, toxaphene, DDE, DDT, and DDD have been detected in at least one of the SVF water bodies in which monitoring has occurred, and in concentrations that exceed water quality objectives (see Appendix C for water quality objectives) and are known to be associated with agricultural operations (Central Valley Water Board 2007a; USGS 2005b, 2005c). Copper also has been detected at multiple locations in the SVF Watershed. Copper is a naturally occurring metal that is also used as a pesticide. Other metals such as arsenic, cadmium, boron, lead, molybdenum, manganese, zinc, iron, and selenium have been detected at elevated levels and are likely mobilized and suspended in agricultural return flows throughout the SVF Watershed (Central Valley Water Board 2007a).

Many of the creeks and drainages located in the SVF Watershed contain low DO. Factors contributing to low DO are still under investigation in the SVF Watershed; however, nutrient loads from irrigated agriculture have been correlated with low DO in the San Joaquin River Basin (Kratzer et al. 2004). Many of the creeks in the SVF Watershed also have experienced fluctuating levels of pH and elevated levels of EC (Central Valley Water Board 2007a).

Table 3-60 summarizes the parameters with one or more concentrations that exceed the applicable water quality objective. The table cites the known source of the contaminants and whether there is a known connection to irrigated agriculture. The creeks and agriculture drains that this table represents are included in the notes at the bottom of the table.

Toxicity tests and TIEs were performed for ILRP monitoring in an attempt to identify the causes of water toxicity in the test organisms. TIEs generally were performed on the water samples that exceeded 50 percent mortality. The results indicated that non-polar organics such as chlorpyrifos, diazinon, dimethoate, disulfton, diuron, cyfluthrin, dioxathion, simazine, and atrazine are causing the large toxicity problem in the SVF Watershed (see Table 3-60) (Central Valley Water Board 2007a).

Table 3-60. Known Agricultural Contaminants and Conditions That Affect Water Quality in the South Valley Floor Watershed

Parameter	Potential Agricultural Source/Contribution to Water Quality Impairment	Sources
Chlorpyrifos	Pesticide used to protect agricultural crops	1
azinphos-methyl	Pesticide used to protect agricultural crops	1
Dimethoate	Pesticide used to protect agricultural crops	1
Malathion	Pesticide used to protect agricultural crops	1
Thiobencarb	Pesticide used to protect agricultural crops	1
Esfenvalerate	Pesticide used to protect agricultural crops	1
Cypermethrin	Pesticide used to protect agricultural crops	1
DDE	Legacy pesticide potentially mobilized by irrigated agricultural operations	1
DDT	Legacy pesticide potentially mobilized by irrigated agricultural operations	1
DDD	Legacy pesticide potentially mobilized by irrigated agricultural operations	1
Toxaphene	Most uses stopped in 1982 but can be used in limited circumstances; when used, is potentially mobilized by irrigated agricultural operations	2
Arsenic	Naturally occurring metal that is partly mobilized and concentrated by irrigated agriculture, causing toxic levels in receiving waters	1
Molybdenum	Occurs naturally but is also used as a pesticide	2
Cadmium	Naturally occurring metal that is partly mobilized and concentrated by irrigated agriculture, causing toxic levels in receiving waters	1
Manganese	Naturally occurring metal that is partly mobilized and concentrated by irrigated agriculture, causing toxic levels in receiving waters	1
Zinc	Naturally occurring metal that is partly mobilized and concentrated by irrigated agriculture, causing toxic levels in receiving waters	1
Iron	Naturally occurring metal that is partly mobilized and concentrated by irrigated agriculture, causing toxic levels in receiving waters	1
Copper	Occurs naturally but is also used as a pesticide	1
Lead	Naturally occurring metal that is partly mobilized and concentrated by irrigated agriculture, causing toxic levels in receiving waters	1
Selenium	Naturally occurring metal that is partly mobilized and concentrated by irrigated agriculture, causing toxic levels in receiving waters	1
Boron	Naturally occurring metal that is partly mobilized and concentrated by irrigated agriculture, causing toxic levels in receiving waters	1
Fecal coliform (*E. coli*)	Likely a result of land application of waste from animal confinement facilities	1

Parameter	Potential Agricultural Source/Contribution to Water Quality Impairment	Sources
DO	Factors contributing to low DO are under investigation. Nutrient loads from irrigated lands may be connected to low DO.	1
EC	Factors contributing to high EC may involve elevated levels of salt on irrigated land.	1
pH	Factors contributing to high pH are under investigation.	1
Toxicity (flea, minnow, algae)	Toxicity identification evaluations (TIEs) indicate that organophosphate insecticides (e.g., chlorpyrifos and diazinon) are linked to much of the observed water toxicity. In addition, cypermethrin, bifenthrin, and lambda-cyhalothrin are linked to much of the observed sediment toxicity.	1, 3

Sources:

[1] Central Valley Water Board 2007a.

[2] USGS 2005b, 2005c.

[3] Weston et al. In Press.

Note: Water bodies in the SVF Watershed for which monitoring data was readily available include Kings River at Manning Avenue, Kings River at Jackson Avenue, Kings River at Reed, Kings River at Lemoore Weir, Tule River at Poplar Avenue, Tule River at McCarthy, Tule River at North Fork, Tule River at Dam Outflow, Tule River at Woods, Goshen Ditch, Button Ditch, Calloway Canal, Cantua Creek, Drain to Wooten Creek, Elbow Creek, Elk Bayou, Fresno Slough, Melga Canal, St. Johns River, Stone Corral Discharge, Cross Creek at 99, Main Drain Canal at 46, I-5 at Panoche Silver Creek, Ditch South of Utica Avenue, King Ditch at 368, Kinestirc Ditch at 201, Mill Creek at 168, Stinson Ditch at Kamm, Turner Ditch at Marks, Outside Creek at Exeter, Packwood Creek, Porter Slough, and Deer Creek at 208.

III.E Grapevine Watershed

General Description

The Grapevine Watershed borders the southernmost portion of the Central Valley (Figure 3-3). The Grapevine Watershed makes up the southern boundary of the Tulare Lake Basin and encompasses approximately 660,756 acres (about 1,032 square miles) (Figure 3-48). The Grapevine Watershed is bounded to the north by the Fellows, South Valley Floor, and Kern River Watersheds. To the south are Ventura and Kern Counties. On the west are San Luis Obispo and Santa Barbara Counties, and on the east is Kern County. The minimum elevation in the watershed is 610 feet, and the maximum elevation is 8,819 feet. There are no major water bodies in the Grapevine Watershed.

The climate of the Grapevine Watershed is highly variable because of the large range in elevation. At the lower elevations, the climate is arid to semi-arid with dry, hot summers and mild winters. Summer temperatures are often higher than 100°F, and winter temperatures are only occasionally below freezing. Conditions are cooler and there is more precipitation at the higher elevations. Snow accumulates in the higher elevations, above about 5,000 feet, and provides some flows in the watershed. However, much of this watershed is below 5,000 feet and most of the precipitation falls as rain. For this reason, most of the streams in the Grapevine Watershed are ephemeral, with higher flows occurring in winter.

Land Use Patterns

Native vegetation is the largest land use type of the Grapevine Watershed, occupying almost the entire watershed (Figure 3-58). Urban land uses occupy approximately 2 percent of the watershed. Irrigated agriculture, water, and barren land each occupy less than 1 percent of land in the watershed. Table 3-61 lists the land use acreage according to DWR and FRAP land use data for the Grapevine Watershed.

Table 3-61. Land Use Acreage according to DWR and FRAP Land Use Data for the Grapevine Watershed

Land Use	Acres	Percent Total
DWR Land Use Type		
Agriculture		
Deciduous Fruits and Nuts	643	0.1
Field Crops	986	0.1
Grain and Hay	1,021	0.2
Pasture	2,361	0.4
Semi agricultural and Incidental	209	0.0
Truck, Nursery, and Berry Crops	762	0.1
Vineyards	5	0.0
Subtotal	5,987	0.9
Urban		
Urban—Unclassified	1,124	0.2
Urban Landscape	182	0.0

Land Use	Acres	Percent Total
Urban Residential	9,506	1.4
Commercial	300	0.0
Industrial	28	0.0
Vacant	425	0.1
Subtotal	11,565	1.8
Native		
Native Vegetation	292,840	44.3
Water Surface	236	0.0
Subtotal	293,076	44.4
FRAP Land Use Type		
Agriculture	263	0.0
Barren/Other	875	0.1
Conifer	76,426	11.6
Desert	2,104	0.3
Hardwood	66,283	10.0
Herbaceous	128,249	19.4
Shrub	72,272	10.9
Urban	3,096	0.5
Water	348	0.1
Wetland	210	0.0
Subtotal	350,126	53.0
Total	**660,756**	**100**

Basin Plan Status

The Tulare Lake Basin Plan (Central Valley Water Board 2004b) describes beneficial uses for waters in the Grapevine Watershed. For the purpose of beneficial use designations, all creeks in the Grapevine Watershed are categorized as part of the west side streams hydrologic unit. Table 3-62 lists beneficial uses for the west side streams.

Table 3-62. Beneficial Uses in the Grapevine Watershed

Beneficial Use	West Side Streams
Municipal & Domestic	
Irrigation	E
Industrial	E
Stock Watering	
Proc	E
Ind	
Power	

Beneficial Use	West Side Streams
Rec-1*	E
Rec-2*	E
Freshwater Habitat—Warm	E
Freshwater Habitat—Cold	
SPWN	
Wildlife Habitat	E
RARE	E
Groundwater Recharge	E
Fresh Water Replenishment	

E = Existing.
RARE = Rare, Threatened, or Endangered Species.
SPWN = Spawning, reproduction, and/or early development.
* Rec-1 indicates recreational activities involving body contact with water, where ingestion of the water is reasonably possible. These uses include, but are not limited to, swimming, wading, water skiing, skin and scuba diving, surfing, white water activities, fishing, and use of natural hot springs. Rec-2 indicates recreational activities involving proximity to water, but generally with no body contact with water or any likelihood of ingestion of water. These include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, and aesthetic enjoyment associated with the above activities.
Source: Central Valley Water Board 2004b.

Hydrology

Creeks in this watershed include both west side and east side creeks. Creeks to the west and south in the Tehachapi Mountains flow east and north toward the South Valley Floor Watershed, and creeks in the east flow west from the Piute Mountains (Figure 3-48). Creeks from the west and south include Comanche Creek, Tecuya Creek, El Paso Creek, Pleito Creek, San Emigdio Creek, Bitterwood Creek, Sandy Creek, Salt Creek, Grapevine Creek, and Pastoria Creek. Creeks from the east include Caliente Creek and Walker Basin Creek, each with several tributaries. These creeks have intermittent ephemeral flows, with much of the water running off due to limited canalization. No flow data are available for these creeks on the USGS or CDEC websites.

Water Quality

There are few, if any, water quality concerns in the Grapevine Watershed. As stated above, there is little to no irrigated agriculture in the Grapevine Watershed; therefore, contaminants from agriculture are not expected to be found in the creeks of this watershed. The creeks of this watershed are dominated by flashy seasonal flows and are expected to contain high total suspended solids for short periods, along with the possibility of naturally occurring heavy metals due in part to settled solids on the first couple layers of soil from grazing and fires.

III.F Coast Range Watershed

General Description

The Coast Range Watershed is located in the northwestern portion of the Tulare Lake Basin (Figure 3-3). To the north are San Benito and Merced Counties and to the south are Kings and Kern Counties. On the west are San Benito and Monterey Counties, and on the east are Fresno and Kings Counties (Figure 3-49). The Coast Range Watershed is approximately 564,990 acres (approximately 883 square miles). The general topography of the Coast Range Watershed varies from small rolling hills to higher coastal mountains. The minimum elevation is 538 feet, the mean elevation is 2,051 feet, and the maximum elevation is 5,213 feet (DWR 2005c). The major water body is Panoche Creek.

The climate of the Coast Range Watershed is arid to semi-arid with dry, hot summers and mild winters. Summer temperatures are often higher than 100°F, and winter temperatures are only occasionally below freezing. Conditions are marginally cooler and there is more precipitation at the higher elevations. Snow may occur in the higher elevations but does not accumulate in quantities that provide substantial source water to creeks in the Coast Range Watershed.

Land Use Patterns

Native vegetation makes up the largest land use in the Coast Range Watershed (approximately 95 percent) (Figure 3-59). Total irrigated land in the watershed accounts for only 1.5 percent of land use, and urban land use comprises less than 1 percent. Table 3-63 includes land use acreage according to DWR and FRAP land use data for the Coast Range Watershed.

Table 3-63. Land Use Acreage according to DWR and FRAP Land Use Data for the Coast Range Watershed

DWR Land Use	Acres	Percent Total
Agriculture		
Deciduous Fruits and Nuts	46	0.0
Field Crops	1	0.0
Grain and Hay Crops	8,343	1.5
Semi agricultural & Incidental to Agriculture	80	0.0
Truck, Nursery, and Berry Crops	9	0.0
Vineyards	27	0.0
Subtotal	8,506	1.5
Urban		
Urban—Unclassified	53	0.0
Industrial	2,453	0.4
Subtotal	2,506	0.4
Native		
Native Vegetation	450,328	78.6
Riparian Vegetation	128	0.0
Subtotal	450,456	78.6

DWR Land Use	Acres	Percent Total
FRAP Land Use Type		
Conifer	438	0.1
Hardwood	65,244	11.4
Herbaceous	12,901	2.3
Shrub	32,844	5.7
Urban	352	0.1
Subtotal	111,779	19.5
Total	**573,247**	**100**

Basin Plan Status

The Tulare Lake Basin Plan (Central Valley Water Board 2004b) describes beneficial uses for waters in the Coast Range Watershed. Table 3-64 lists beneficial uses for west side streams.

Table 3-64. Beneficial Uses in the Coast Range Watershed

Beneficial Use	West Side Streams
Municipal & Domestic	
Irrigation	E
Industrial	E
Stock Watering	
Proc	E
Industry	
Power	
Rec-1*	E
Rec-2*	E
Freshwater Habitat——Warm	E
Freshwater Habitat—Cold	
SPWN	
Wildlife Habitat	E
RARE	E
Groundwater Recharge	E
Fresh Water Replenishment	

E = Existing.
RARE = Rare, Threatened, or Endangered Species.
SPWN = Spawning, Reproduction and/or Early Development.
* Rec-1 indicates recreational activities involving body contact with water, where ingestion of the water is reasonably possible. These uses include, but are not limited to, swimming, wading, water skiing, skin and scuba diving, surfing, white water activities, fishing, and use of natural hot springs. Rec-2 indicates recreational activities involving proximity to water, but generally with no body contact with water or

Beneficial Use	West Side Streams
any likelihood of ingestion of water. These include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, and aesthetic enjoyment associated with the above activities.	
Source: Central Valley Water Board 2004b.	

Hydrology

Panoche Creek drains a portion of the Coast Range Watershed into the southern San Joaquin Valley floor (Figure 3-49). Panoche Creek consists of many small tributaries that typically dry up during summer and have flashy seasonal pulse flows during the storm season. Upstream tributaries to Panoche Creek (upstream of the Silver Creek inflow) include Grisswald, Las Aguilas, Payne, and Antelope Creeks. One of the most important downstream tributaries is Silver Creek, which is the last primary inflow to Panoche Creek. The upstream portion of Silver Creek receives inflow from San Carlos Creek.

Much of the Panoche Creek Watershed does not contain irrigated agriculture until Panoche Creek reaches the southern San Joaquin Valley floor; this portion of the creek is discussed in the South Valley Floor Watershed section. The USGS website contained flow data for Panoche Creek but no data for any tributaries along Panoche Creek. Monthly average flows for Panoche Creek from 1998 to 2004 range from 0 to approximately 300 cfs, as shown in Table B-32 in Appendix B. The flow data for Panoche Creek near I-5 are from a station just outside the border of the Coast Range Watershed; however, it is the best representative flow station available for the watershed. The flow data validate the flashy storm-season pulse flows that occur in Panoche Creek. Only very rarely does runoff reach the San Joaquin River, and this requires extreme flood conditions.

Many small tributaries in the southern portion of the Coast Range Watershed contain seasonal pulse flows. The main creeks are Cantua Creek, Martinez Creek, Salt Creek, Domengine Creek, and Los Gatos Creek. The portions of these creeks that are in the Coast Range Watershed do not contain irrigated agriculture. However, during the storm season, flows from these seasonal creeks sometimes flow into the southern San Joaquin Valley where agriculture is present. The USGS website contained flow data for Los Gatos Creek and Cantua Creek. No flow data were available for other creeks. Monthly average flow data from 1995 to 2004 for Los Gatos Creek and Cantua Creek are included in Appendix B, Table B-32. Flow data represent the flashy storm-season pulse flows that occur in these west side drainages.

Water Quality

Many small ephemeral creeks drain occasionally into the southern San Joaquin Valley from the Coast Ranges. When this drainage occurs during the storm season, Panoche and San Carlos Creeks carry a high sediment and heavy metal load. Mercury impairments are a result of resource extraction from abandoned mines in the Coast Ranges. Sedimentation/siltation and elevated selenium concentrations are a result of agriculture, agriculture-grazing, and construction-related ground disturbance. A USGS Water Resources Investigations Report identifies Panoche Creek as having some of the world’s largest natural deposits of selenium (Kratzer et al. 2003). This natural selenium, along with similar deposits of boron and other salts, contributes to the contamination of Panoche Creek. In addition, development of the lower watershed has virtually eliminated the creek channel, promoting flooding and sediment deposition with its load of selenium, boron, and other salts into the downstream watershed (Kratzer et al. 2003).

As part of this evaluation, measurements exceeding a water quality objective were included. The objectives were generally the lowest criteria contained in Appendix C. Table 3-65 contains water quality data for selenium and sediment. Data indicate that Panoche Creek contains elevated levels of selenium and sedimentation (Central Valley Water Board 2007a, Kratzer et al. 2003, USGS 2005b, 2005c).

Table 3-65. Known Agricultural Contaminants and Conditions That Affect Water Quality in the Coast Range Watershed

Parameter	Potential Agricultural Sources/Contribution to Water Quality Impairment	Sources
Selenium	Naturally occurring metal that is mobilized and concentrated in the Panoche Creek Watershed from flashy intermittent flows. In the valley, where irrigated agriculture is more prevalent, selenium also may be mobilized and concentrated by agriculture return flows.	1, 2, 3
Sediment	Sediment is naturally occurring and can transport other hydrophobic contaminants. Sediment also can smother filter-feeding organisms.	1, 2, 3

Sources:
[1] Central Valley Water Board 2007a.
[2] Kratzer et al. 2003.
[3] USGS 2005b, 2005c.
Note: This table applies to Panoche Creek.

The Arroyo Pasajero Watershed is located on the eastern slope of the Coast Ranges in southwestern Fresno County. Several creeks flow from the watershed into Pleasant Valley and form Arroyo Pasajero Creek east of Coalinga and west of the California Aqueduct. The largest of these creeks is Los Gatos Creek. There are several inactive or abandoned asbestos mines in the watershed. Two of these mines, the Coalinga Asbestos Mine and the Atlas Asbestos Mine, are Superfund cleanup sites. The Atlas Mine is located at the head of White Creek and the Coalinga Mine is located at the head of Pine Canyon Creek. Both White Creek and Pine Canyon Creek are tributaries of Los Gatos Creek. There is a possibility that asbestos fibers from the watershed migrate to the California Aqueduct through the Arroyo Pasajero Inlet. Waterborne asbestos fibers may be carcinogenic given a sufficient quantity and prolonged, constant exposure. DWR constructed a ponding basin to allow asbestos and sediment to settle out of the water before it is allowed to flow into the California Aqueduct, significantly decreasing the amount of asbestos entering the California Aqueduct.

III.G Fellows Watershed

General Description

The Fellows Watershed is located in the southern portion of the Central Valley on the west side (Figure 3-3). The Fellows Watershed is the smallest in the Tulare Lake Basin and accounts for approximately 34,398 acres (about 54 square miles). To the north is the Temblor Watershed, and to the south is the Grapevine Watershed. On the east is the South Valley Floor Watershed, and on the west is San Luis Obispo County. The general topography of the Fellows Watershed is typical of the Coast Ranges. The minimum elevation is 1,099 feet, and the maximum elevation is 3,944 feet (DWR 2005c). Figure 3-50 identifies the Fellows Watershed. Only small ephemeral creeks drain from the Fellows Watershed.

The climate of the Fellows Watershed is highly variable because of the large range in elevation. At the lower elevations, the climate is arid to semi-arid with dry, hot summers and mild winters. Summer temperatures are often higher than 100°F, and winter temperatures are only occasionally below freezing. Conditions are cooler and there is more precipitation at the higher elevations. Although snow may occur in the higher elevations on rare occasions, snow does not provide a substantial source of flow in the Fellows Watershed.

Land Use Patterns

Virtually all of the land use in the Fellows Watershed is native vegetation (Figure 3-60). Approximately 15 percent is desert, and 0.02 percent (6 acres) is defined as urban land use. The DWR land use data and FRAP vegetation data do not define any irrigated agriculture in the Fellows Watershed. Table 3-66 contains DWR and FRAP land use data for the Fellows Watershed.

Table 3-66. Land Use Acreage according to DWR and FRAP Land Use Data for the Fellows Watershed

Land Use	Acres	Percent Total
DWR Land Use Type		
Native Vegetation	15,685	45.6
FRAP Land Use Type		
Desert	5,075	14.8
Hardwood	272	0.8
Herbaceous	13,359	38.8
Urban	6	0.0
Total	**34,398**	**100**

Basin Plan Status

The Tulare Lake Basin Plan (Central Valley Water Board 2004b) describes beneficial uses for waters in the Fellows Watershed. The Tulare Lake Basin Plan combines all beneficial uses of the west side streams into one designation. Table 3-67 lists beneficial uses for the west side streams.

Table 3-67. Beneficial Uses in the Fellows Watershed

Beneficial Use	West Side Streams
Municipal & Domestic	
Irrigation	E
Industrial	E
Stock Watering	
Proc	E
Industry	
Power	
Rec-1*	E
Rec-2*	E
Freshwater Habitat—Warm	E
Freshwater Habitat—Cold	
SPWN	
Wildlife Habitat	E
RARE	E
Groundwater Recharge	E
Freshwater Replenishment	

E = Existing.

RARE = Rare, Threatened, or Endangered Species.

SPWN = Spawning, reproduction, and/or early development.

* Rec-1 indicates recreational activities involving body contact with water, where ingestion of the water is reasonably possible. These uses include, but are not limited to, swimming, wading, water skiing, skin and scuba diving, surfing, white water activities, fishing, and use of natural hot springs. Rec-2 indicates recreational activities involving proximity to water, but generally with no body contact with water or any likelihood of ingestion of water. These include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, and aesthetic enjoyment associated with the above activities.

Source: Central Valley Water Board 2004b.

Hydrology

A few small ephemeral creeks drain into the Tulare Lake Bed from the Fellows Watershed (Figure 3-50). These coastal creeks tend to have flows only occasionally during the storm season. From north to south the creeks are Buena Vista Creek, Broad Creek, Sandy Creek, and Bitterwater Creek. There are no available flow data for any of these creeks on the USGS or CDEC websites. However, the City of Taft discharges to Sandy Creek and has an NPDES permit with the Central Valley Water Board.

Water Quality

There are few, if any, water quality concerns in the Fellows Watershed. As stated above, there is no irrigated agriculture in the Fellows Watershed; therefore, contaminants from agriculture are not expected to be found in the creeks. Because the creeks within this watershed are dominated by flashy seasonal flows, they are expected to contain high total suspended solids for a short period, including the possibility of naturally occurring heavy metals. This watershed contains no 2006 Section 303(d) listings, and water quality is not analyzed further in this report.

III.H Temblor Watershed

General Description

The Temblor Watershed is part of the Coast Ranges on the west side of the Tulare Lake Basin (Figure 3-3). To the north is the Sunflower Valley Watershed, and to the south is the Fellows Watershed. On the east is the South Valley Floor Watershed, and on the west is San Luis Obispo County. The Temblor Watershed encompasses approximately 176,279 acres (about 275 square miles). Topography in the Temblor Watershed is typical of the Coast Ranges. The minimum elevation is 502 feet, the mean elevation is 3,783 feet, and the maximum elevation is 4,285 feet (DWR 2005c). Figure 3-51 shows the Temblor Watershed.

The climate of the Temblor Watershed is highly variable because of the large range in elevation. At the lower elevations, the climate is arid to semi-arid with dry, hot summers and mild winters. Summer temperatures are often higher than 100°F, and winter temperatures are only occasionally below freezing. Conditions are cooler and there is more precipitation at the higher elevations. It may snow in the upper elevations of the Temblor Watershed, but snow very rarely accumulates in large amounts and does not contribute substantially to stream flows in the Temblor Watershed.

Land Use Patterns

Like most other watersheds that are not in the southern San Joaquin Valley floor, native vegetation is the dominant land use in the Temblor Watershed (Figure 3-61). Total urban land use in the watershed is less than 1 percent. Total irrigated agriculture accounted for approximately 3.3 percent of the land use. Table 3-68 contains land use acreage according to DWR and FRAP land use data for the Temblor Watershed.

Table 3-68. Land Use Acreage according to DWR and FRAP Land Use Data for the Temblor Watershed

Land Use	Acres	Percent Total
DWR Land Use Type		
Grain and Hay Crops	5,581	3.2
Industrial	2	0.0
Native Vegetation	101,763	57.7
Semi agricultural & Incidental to Agriculture	63	0.0
Vineyards	50	0.0
Water Surface	56	0.0
FRAP Land Use Type		
Agriculture	128	0.1
Barren/Other	96	0.1
Conifer	727	0.4
Desert	1,918	1.1
Hardwood	8,351	4.7

Land Use	Acres	Percent Total
Herbaceous	48,586	27.6
Shrub	8,369	4.7
Urban	584	0.3
Water	5	0.0
Total	**176,279**	**100**

Basin Plan Status

The Tulare Lake Basin Plan (Central Valley Water Board 2004b) describes beneficial uses for waters in the Temblor Watershed. The Tulare Lake Basin Plan combines all west side streams beneficial uses into one designation. Table 3-69 lists beneficial uses for the west side streams.

Table 3-69. Beneficial Uses in the Temblor Watershed

Beneficial Use	West Side Streams
Municipal & Domestic	
Irrigation	E
Industrial	E
Stock Watering	
Proc	E
Ind	
Power	
Rec-1*	E
Rec-2*	E
Freshwater Habitat—Warm	E
Freshwater Habitat—Cold	
SPWN	
Wildlife Habitat	E
RARE	E
Groundwater Recharge	E
Fresh Water Replenishment	

E = Existing.

RARE = Rare, Threatened, or Endangered Species.

SPWN = Spawning, reproduction, and/or early development.

* Rec-1 indicates recreational activities involving body contact with water, where ingestion of the water is reasonably possible. These uses include, but are not limited to, swimming, wading, water skiing, skin and scuba diving, surfing, white water activities, fishing, and use of natural hot springs. Rec-2 indicates recreational activities involving proximity to water, but generally with no body contact with water or any likelihood of ingestion of water. These include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, and aesthetic enjoyment

Beneficial Use	West Side Streams
associated with the above activities.	
Source: Central Valley Water Board 2004b.	

Hydrology

Many small creeks drain into the Tulare Lake Bed from the Temblor Watershed; however, most are ephemeral (Figure 3-51). From north to south these creeks include the Francisco Creek, Packwood Creek, Bitterwater Creek, Devilwater Creek, Media Agua Creek, Walnut Creek, Yeguas Creek, Santos Creek, Chico Martinez Creek, and Temblor Creek. No flow data are available for any of these creeks on the USGS or CDEC websites.

Water Quality

There are few, if any, water quality concerns in the Temblor Watershed. As stated above, irrigated agriculture accounts for only 3.3 percent of the land use in the watershed, and contaminants from agriculture have not been found in the creeks of this watershed. The creeks of this watershed are dominated by flashy seasonal flows and are expected to contain high total suspended solids for a short period, along with the possibility of naturally occurring heavy metals. There are no 2006 Section 303(d) listings for streams within this watershed, and water quality is not analyzed further in this report.

III.I Sunflower Valley Watershed

General Description

The Sunflower Valley Watershed is part of the Coast Ranges on the west side of the Tulare Lake Basin (Figure 3-3). North of the Sunflower Valley Watershed is the Coast Ranges; to the south is the Temblor Watershed. On the east is the South Valley Floor Watershed, and on the west are Monterey and San Luis Obispo Counties. The Sunflower Valley Watershed is approximately 93,042 acres (about 145 square miles). The general topography of the Sunflower Valley Watershed is typical of the Coast Ranges. The minimum elevation in the watershed is 453 feet, and the maximum elevation is 4,324 feet (DWR 2005c). Figure 3-52 shows the Sunflower Valley Watershed. Five main creeks make up the Sunflower Valley Watershed.

The climate of the Sunflower Valley Watershed is arid to semi-arid with dry, hot summers and mild winters. Summer temperatures may be higher than 100°F, and winter temperatures are only occasionally below freezing. It may snow on occasion in the upper elevations of the Sunflower Valley Watershed, but snow very rarely accumulates due to the lower elevations and does not provide substantial flow to streams in the Sunflower Valley Watershed.

Land Use Patterns

Native vegetation makes up the majority of the Sunflower Valley Watershed (Figure 3-62). Total urban land use makes up less than 1 percent of the land in the watershed, and irrigated agriculture accounts for less than 1 percent. Table 3-70 includes land use acreage according to DWR and FRAP land use data for the Sunflower Valley Watershed.

Table 3-70. Land Use Acreage according to DWR and FRAP Land Use Data for the Sunflower Valley Watershed

DWR Land Use Type	Acres	Percent Total
Deciduous Fruits and Nuts	19	0.0
Field Crops	1	0.0
Grain and Hay Crops	76	0.1
Native Vegetation	85,445	91.8
Pasture	457	0.5
Semi agricultural and Incidental to Agriculture	3	0.0
Vineyards	55	0.1
Water Surface	2	0.0
FRAP Land Use Type		
Hardwood	400	0.4
Herbaceous	4,103	4.4
Shrub	2,411	2.6
Urban	70	0.1
Total	**93,042**	**100**

Basin Plan Status

The Tulare Lake Basin Plan (Central Valley Water Board 2004b) describes beneficial uses for waters in the Sunflower Valley Watershed. The Tulare Lake Basin Plan combines all beneficial uses of the west side streams into one designation. Table 3-71 lists beneficial uses for the west side streams in the watershed.

Table 3-71. Beneficial Uses in the Sunflower Valley Watershed

Beneficial Use	West Side Streams
Municipal & Domestic	
Irrigation	E
Industrial	E
Stock Watering	
Proc	E
Ind	
Power	
Rec-1*	E
Rec-2*	E
Freshwater Habitat—Warm	E
Freshwater Habitat—Cold	
SPWN	
Wildlife Habitat	E
RARE	E
Groundwater Recharge	E
Fresh Water Replenishment	

E = Existing
RARE = Rare, Threatened, or Endangered Species.
SPWN = Spawning, reproduction, and/or early development.
* Rec-1 indicates recreational activities involving body contact with water, where ingestion of the water is reasonably possible. These uses include, but are not limited to, swimming, wading, water skiing, skin and scuba diving, surfing, white water activities, fishing, and use of natural hot springs. Rec-2 indicates recreational activities involving proximity to water, but generally with no body contact with water or any likelihood of ingestion of water. These include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, and aesthetic enjoyment associated with the above activities.
Source: Central Valley Water Board 2004b.

Hydrology

Like the Coast Range Watershed, flashy streams tend to dominate during the storm season and dry up during summer. Five main creeks make up the Sunflower Valley Watershed (Figure 3-52). From north to south, they are Garza Creek, Baby King Creek, Big Tar Creek, Avenal Creek, and Cottonwood Creek. The USGS and CDEC websites contained flow data for only one of these creeks. Monthly minimum, mean, and maximum flows from 1975 to 1986 for Avenal Creek are included in Appendix B, Table B-33.

Water Quality

There are few, if any, water quality concerns in the Sunflower Valley Watershed. As stated above, irrigated agriculture accounts for less than 1 percent of the land use in the watershed, and contaminants for agriculture are not expected to be found in the creeks of this watershed. The creeks in this watershed are dominated by flashy flows and are expected to contain high total suspended solids for a short period, with the possibility of containing naturally occurring heavy metals. This watershed contains no 2006 Section 303(d)-listed water bodies, and water quality is not analyzed further in this report.

III.J Southern Sierra Watershed

General Description

The Southern Sierra Watershed is located south of the Kaweah River and north of the Kern River. On the east are the Kern River and the Sierra Nevada, and on the west is the Valley Floor (Figure 3-3). The Southern Sierra Watershed is bounded on the east and south by the Kern River Watershed, on the west by the South Valley Floor Watershed, and to the north by the Kaweah Watershed. The Tule River, Deer Creek, and White River are the main watersheds in the overall Southern Sierra Watershed. Together they occupy 665,472.83 acres of generally steep topography (DWR 2005c). Figure 3-53 shows the Southern Sierra Watershed. More than half of the mountainous portion of the watershed lies within Sequoia National Forest. The minimum elevation in the watershed is 518 feet, and the maximum elevation in the watershed is 10,226 feet.

The climate of the Southern Sierra Watershed is highly variable because of the large range in elevation. At the lower elevations, the climate is arid to semi-arid with dry, hot summers and mild winters. Summer temperatures are often higher than 100°F, and winter temperatures are only occasionally below freezing. Conditions are cooler and there is more precipitation at the higher elevations. The winter snowpack, which accumulates in the higher elevations, supplies much of the water in this watershed.

Land Use Patterns

Native vegetation is the dominant land use type in the Southern Sierra Watershed (Figure 3-63). Urban, irrigated agriculture, surface water, and barren land each make up less than 1 percent of land use in the region. These percentages can be attributed to the large Sequoia National Forest and Tule Indian Reservation land holdings. Table 3-72 lists land use acreage according to DWR and FRAP land use data for the Southern Sierra Watershed.

Table 3-72. Land Use Acreage according to DWR and FRAP Land Use Data for the Southern Sierra Watershed

Land Use	Acres	Percent Total
DWR Land Use Type		
Agriculture		
Deciduous Fruits and Nuts	119	0.0
Grain and Hay Crops	222	0.0
Idle	72	0.0
Pasture	910	0.1
Semi agricultural and Incidental to Agriculture	101	0.0
Vineyards	2	0.0
Subtotal	1,426	0.2
Urban		
Urban—Unclassified	762	0.1
Urban Landscape	159	0.0

Land Use	Acres	Percent Total
Commercial	55	0.0
Industrial	157	0.0
Residential	633	0.1
Vacant	22	0.0
Subtotal	1,788	0.3
Native		
Native Vegetation	142,278	21.4
Riparian Vegetation	715	0.1
Water Surface	2,644	0.4
Subtotal	145,637	21.9
FRAP Land Use Type		
Barren/Other	4,440	0.7
Conifer	104,322	15.7
Hardwood	239,054	35.9
Herbaceous	131,923	19.8
Shrub	36,011	5.4
Urban	674	0.1
Water	22	0.0
Wetland	175	0.0
Subtotal	516,621	77.6
Total	**665,473**	**100**

Basin Plan Status

The Tulare Lake Basin Plan (Central Valley Water Board 2004b) describes beneficial uses for waters in the Southern Sierra Watershed. Table 3-73 lists the beneficial uses of the Upper Tule River above Success Dam. The designated beneficial uses also apply to Dry Creek and the White River.

Table 3-73. Beneficial Uses in the Southern Sierra Watershed

Beneficial Use	Tule River above Lake Success
Municipal and Domestic	E
Agriculture	E
Industrial Service	
Industrial Process	
Hydropower Generation	E
Rec-1*	E
Rec-2*	E
Freshwater Habitat—Warm	E
Freshwater Habitat—Cold	E

Beneficial Use	Tule River above Lake Success
Wildlife Habitat	E
Rare, Threatened, or Endangered Species	E
Spawning, Reproduction, and/or Early Development	E
Groundwater Recharge	
Freshwater Replenishment	E
Preservation of Biological Habitats of Special Significance	

E = Existing.

*Rec-1 indicates recreational activities involving body contact with water, where ingestion of the water is reasonably possible. These uses include, but are not limited to, swimming, wading, water skiing, skin and scuba diving, surfing, white water activities, fishing, and use of natural hot springs. Rec-2 indicates recreational activities involving proximity to water, but generally with no body contact with water or any likelihood of ingestion of water. These include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, and aesthetic enjoyment associated with the above activities.

Beneficial use categories in the Tulare Lake Basin vary slightly from those in the Sacramento–San Joaquin Rivers Basin Plan.

Source: Central Valley Water Board 2004b.

Hydrology

The southern portion of the Southern Sierra Watershed includes the Tule River Indian Reservation. The Upper Tule River's three forks—the North, Middle, and South—flow southwest or west into Success Reservoir (Figure 3-53). All three forks are fed by a multitude of small streams. The Upper Tule River flow varies seasonally, with the lowest flows (approximately 0 cfs) in late summer (August and September) and the highest flows (approximately 1,100 cfs) in spring (February through May) (see Table B-34 in Appendix B).

Deer Creek Watershed is located south of the Tule River Watershed and north of the White River Watershed. Steep mountainous terrain makes up the majority of the upper Deer Creek watershed; this watershed drains the western slope of the Greenhorn Mountains, which is part of the Sierra Nevada. The maximum elevation in the Deer Creek Watershed is 8,300 feet. Water generally flows west from this elevation through the foothills and crosses the South Valley. Flow data were not available for Deer Creek in the Southern Sierra Watershed. For more information on the lower portion of Deer Creek and its downstream flow, see the South Valley Floor Watershed section.

The White River Watershed, located south of Deer Creek Watershed and north of Poso Creek Watershed, drains a portion of the Greenhorn Mountains, flowing westward into the South Valley toward Tulare Lake Bed. For additional information on the lower reaches of White River, see the South Valley Floor Watershed section. Like the Deer Creek Watershed, the maximum elevation in the White River Watershed is 8,300 feet, with steep mountainous terrain in the upper watershed and foothills as the White River approaches the valley floor. Flow data were not available for White River in the Southern Sierra Watershed. For downstream flow data, see the South Valley Floor Watershed section.

Water Quality

There are few, if any, water quality concerns in the Southern Sierra Watershed. No 2006 Section 303(d)-listed pollutants are associated with the Upper Tule River. Generally, all physical parameters such as EC, pH, temperature, and turbidity are within Basin Plan standards.